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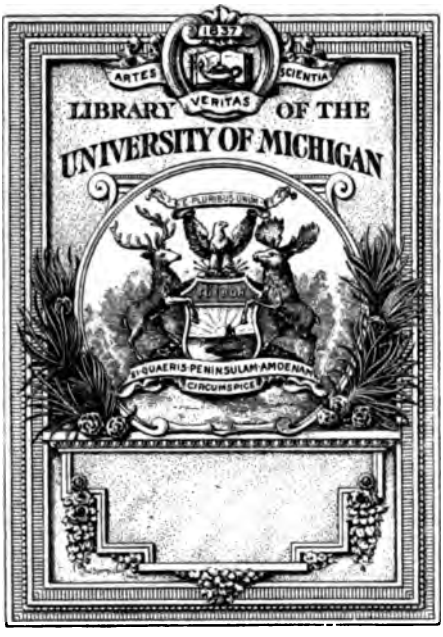
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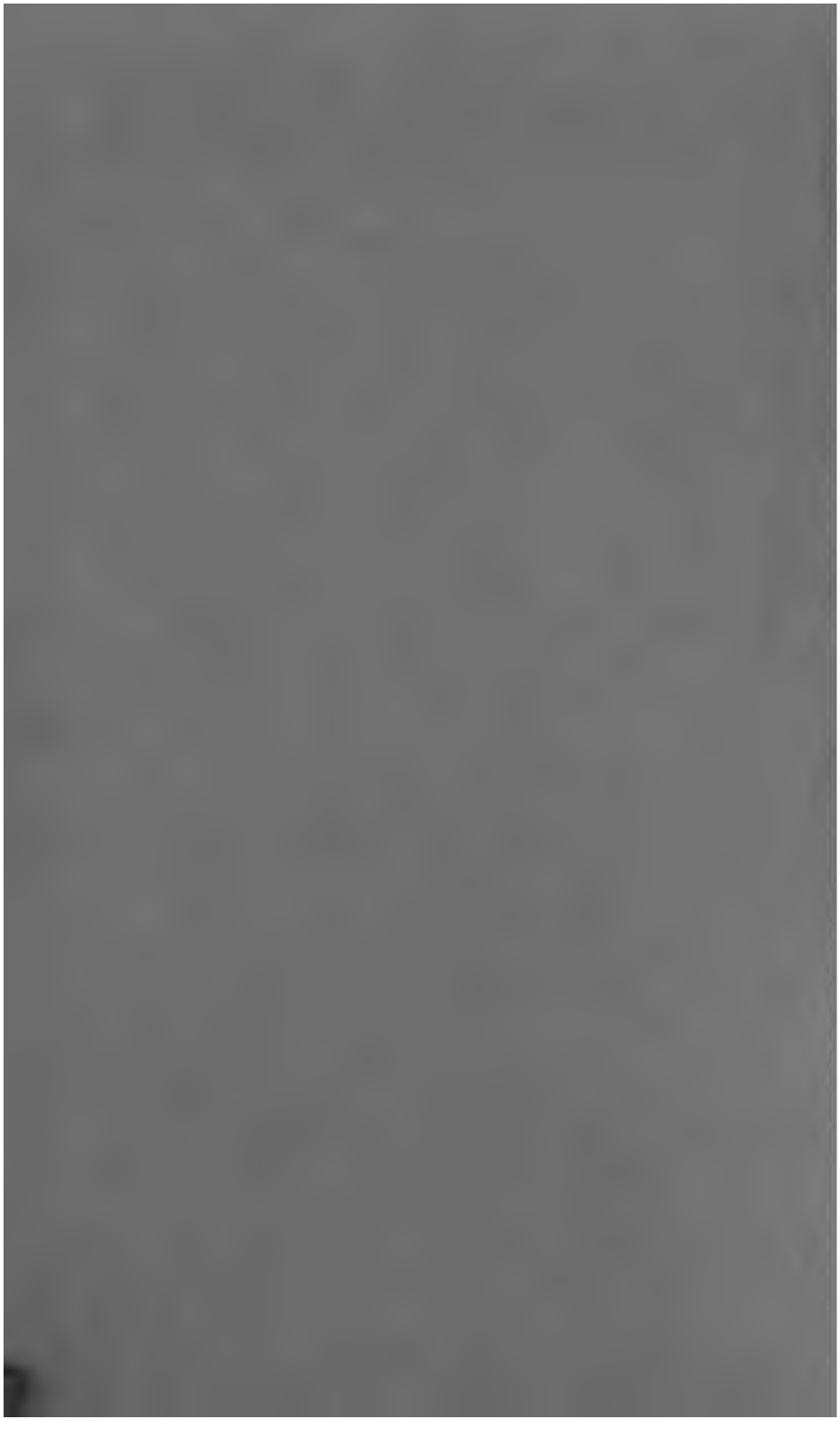
PROCEEDINGS OF THE

Indiana Academy of Science

1903



PROCEEDINGS

OF THE

Indiana Academy of Science

1903.

EDITOR, - - WILLIAM J. KARSLAKE.

ASSOCIATE EDITORS:

AMOS BUTLER, W. S. BLATCHLEY,
C. H. EIGENMANN, P. N. EVANS,
DONALDSON BODINE, THOMAS GRAY,
JOHN S. WRIGHT.

INDIANAPOLIS, IND.
1904.

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1904.

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AN ACT TO PROVIDE FOR THE PUBLICATION OF THE REPORTS AND PAPERS OF THE INDIANA ACADEMY OF SCIENCE.

[Approved March 11, 1895.]

Preamble.

WHEREAS, The Indiana Academy of Science, a chartered scientific association, has embodied in its constitution a provision that it will, upon the request of the Governor, or of the several departments of the State government, through the Governor, and through its council as an advisory body, assist in the direction and execution of any investigation within its province, without pecuniary gain to the Academy, provided only that the necessary expenses of such investigation are borne by the State; and,

WHEREAS, The reports of the meetings of said Academy, with the several papers read before it, have very great educational, industrial and economic value, and should be preserved in permanent form; and

WHEREAS, The Constitution of the State makes it the duty of the General Assembly to encourage by all suitable means intellectual, scientific and agricultural improvement; therefore,

Publication of the Reports of the Indiana Academy of Science.

SECTION 1. *Be it enacted by the General Assembly of the State of Indiana*, That hereafter the annual reports of the meetings of the Indiana Academy of Science, beginning with the report for the year 1894, including all papers of scientific or economic value, presented at such meetings, after they shall have been edited and prepared for publication as hereinafter provided, shall be published by and under the direction of the Commissioners of Public Printing and Binding.

Editing Reports.

SEC. 2. Said reports shall be edited and prepared for publication without expense to the State, by a corps of editors to be selected and appointed by the Indiana Academy of Science, who shall not, by reason of such services, have any claim against the State for compensation. The form, style of binding, paper, typography and manner and extent of illustration of such reports, shall be determined by the editors, subject to the approval of the Commissioners of Public Printing and Stationery. Not less than 1,500 nor more than 3,000 copies of each

Number of printed Reports.

of said reports shall be published, the size of the edition within said limits to be determined by the concurrent action of the editors and the Commissioners of Public Printing and Stationery: *Provided*, That not to exceed six hundred dollars ($600) shall be expended for such publication in any one year, and not to extend beyond 1896: *Provided*, That no sums shall be deemed to be appropriated for the year 1894.

Proviso.

SEC. 3. All except three hundred copies of each volume of said reports shall be placed in the custody of the State Librarian, who shall furnish one copy thereof to each public library in the State, one copy to each university, college or normal school in the State, one copy to each high school in the State having a library, which shall make application therefor, and one copy to such other institutions, societies or persons as may be designated by the Academy through its editors or its council. The remaining three hundred copies shall be turned over to the Academy to be disposed of as it may determine. In order to provide for the preservation of the same it shall be the duty of the Custodian of the State House to provide and place at the disposal of the Academy one of the unoccupied rooms of the State House, to be designated as the office of the Indiana Academy of Science, wherein said copies of said reports belonging to the Academy, together with the original manuscripts, drawings, etc., thereof can be safely kept, and he shall also equip the same with the necessary shelving and furniture.

Disposition of Reports.

SEC. 4. An emergency is hereby declared to exist for the immediate taking effect of this act, and it shall therefore take effect and be in force from and after its passage.

Emergency.

AN ACT FOR THE PROTECTION OF BIRDS, THEIR NESTS AND EGGS.

[Approved March 5, 1891.]

Birds.

SECTION 1. *Be it enacted by the General Assembly of the State of Indiana*, That it shall be unlawful for any person to kill any wild bird other than a game bird, or purchase, offer for sale any such wild bird after it has been killed, or to destroy the nests or the eggs of any wild bird.

Game Birds.

SEC. 2. For the purpose of this act the following shall be considered game birds: the Anatidæ, commonly called swans, geese, brant, and river and sea ducks; the Rallidæ, commonly known as rails, coots, mudhens, and gallinules; the Limicolæ, commonly known as shore birds, plovers, surf birds, snipe, woodcock and sandpipers, tattlers and curlews; the Gallinæ, commonly known as wild turkeys, grouse, prairie chickens, quail, and pheasants, all of which are not intended to be affected by this act.

Penalty.

SEC. 3. Any person violating the provisions of Section 1 of this act shall, upon conviction, be fined in a sum not less than ten nor more than fifty dollars, to which may be added imprisonment for not less than five days nor more than thirty days.

Permits.

SEC. 4. Sections 1 and 2 of this act shall not apply to any person holding a permit giving the right to take birds or their nests and eggs for scientific purposes, as provided in Section 5 of this act.

Permits to Science.

SEC. 5. Permits may be granted by the Executive Board of the Indiana Academy of Science to any properly accredited person, permitting the holder thereof to collect birds, their nests or eggs for strictly scientific purposes. In order to obtain such permit the applicant for the same must present to said Board written testimonials from two well-known scientific men certifying to the good character and fitness of said applicant to be entrusted with such privilege, and pay to said Board one dollar to defray the necessary expenses attending the granting of such permit, and must file with said Board a properly executed bond in the sum of two hundred dollars, signed by at least two responsible citizens of the State as sureties. The bond shall be forfeited to the State and the permit become void upon proof that the holder of

Bond.

Bond forfeited.

such permit has killed any bird or taken the nests or eggs of any bird for any other purpose than that named in this section, and shall further be subject for each offense to the penalties provided in this act.

Two years.

SEC. 6. The permits authorized by this act shall be in force for two years only from the date of their issue, and shall not be transferable.

Birds of prey.

SEC. 7. The English or European House Sparrow (Passer domesticus), crows, hawks, and other birds of prey are not included among the birds protected by this act.

Acts repealed.

SEC. 8. All acts or parts of acts heretofore passed in conflict with the provisions of this act are hereby repealed.

Emergency.

SEC. 9. An emergency is declared to exist for the immediate taking effect of this act, therefore the same shall be in force and effect from and after its passage.

OFFICERS—1903–1904.

PRESIDENT,
CARL L. MEES.

VICE-PRESIDENT,
GLENN CULBERTSON.

SECRETARY,
JOHN S. WRIGHT.

ASSISTANT SECRETARY,
J. H. RANSOM.

PRESS SECRETARY,
G. A. ABBOTT.

TREASURER,
WILLIAM A. McBETH.

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CURATORS.

BOTANY ..... J. C. ARTHUR.
ICHTHYOLOGY ..... C. H. EIGENMANN.
HERPETOLOGY, MAMMALOGY, ORNITHOLOGY ..... AMOS W. BUTLER.
ENTOMOLOGY ..... W. S. BLATCHLEY.

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MEMBERSHIP.

STANLEY COULTER, G. A. ABBOTT, A. L. FOLEY.

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AUDITING.

MEL. T. COOK, WM. J. KARSLAKE.

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STANLEY COULTER, A. J. BIGNEY, O. L. KELSO.

LEGISLATION FOR THE RESTRICTION OF WEEDS.

M. B. THOMAS, D. M. MOTTIER, C. C. DEAM.

PROPAGATION AND PROTECTION OF GAME AND FISH.

C. H. EIGENMANN, A. W. BUTLER, GLENN CULBERTSON.

EDITOR.

W. J. KARSLAKE, Butler College, Indianapolis.
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RELATIONS OF THE ACADEMY TO THE STATE.

C. A. WALDO, WILLIAM WATSON WOOLLEN, R. W. MCBRIDE.

GRANTING PERMITS FOR COLLECTING BIRDS AND FISHES.

A. W. BUTLER, D. W. DENNIS, W. J. MOENKHAUS.

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THOMAS GRAY, DONALDSON BODINE, L. J. RETTGER, H. L. BRUNER, JOHN S. WRIGHT, W. J. KARSLAKE.

OFFICERS OF THE INDIANA ACADEMY OF SCIENCE.

	PRESIDENT.	SECRETARY.	ASST. SECRETARY.	PRESS SECRETARY.	TREASURER.
1885–6.....	David S. Jordan..	Amos W. Butler..	....	.....	O. P. Jenkins.
1886–7.....	John M. Coulter..	Amos W. Butler..	.....	.....	O. P. Jenkins.
1887–8.....	J. P. D. John.....	Amos W. Butler..	.....	.....	O. P. Jenkins.
1888–9.....	John C. Branner..	Amos W. Butler..	.....	.....	O. P. Jenkins.
1889–90....	T. C. Mendenhall.	Amos W. Butler..	.....	.....	O. P. Jenkins.
1890–1.....	O. P. Hay.....	Amos W. Butler..	....	.....	O. P. Jenkins.
1891–2.....	J. L. Campbell...	Amos W. Butler..	....	....	C. A. Waldo.
1892–3.....	J. C. Arthur.....	Amos W. Butler..	Stanley Coulter W. W. Norman }	.....	C. A. Waldo.
1893–4.....	W. A. Noyes	C. A. Waldo.....	W. W. Norman.....	... .	W. P. Shannon.
1894–5.....	A. W. Butler.....	John S. Wright...	A. J. Bigney.....	.....	W. P. Shannon.
1895–6.....	Stanley Coulter...	John S. Wright...	A. J. Bigney.....	.....	W. P. Shannon.
1896–7.....	Thomas Gray.....	John S. Wright...	A. J. Bigney	.....	W. P. Shannon.
1897–8.....	C. A. Waldo.....	John S. Wright..	A. J. Bigney.....	Geo. W. Benton ...	J. T. Scovell.
1898–9.....	C. H. Eigenmann.	John S. Wright...	E. A. Schultze	Geo. W. Benton ...	J. T. Scovell.
1899–1900..	D. W. Dennis.....	John S. Wright...	E. A. Schultze	Geo. W. Benton ...	J. T. Scovell.
1900–1901..	M. B. Thomas ..	John S. Wright...	E. A. Schultze	Geo. W. Benton ...	J. T. Scovell.
1901–1902	Harvey W. Wiley	John S. Wright...	Donaldson Bodine.....	Geo. W. Benton ...	J. T. Scovell.
1902–1903..	W. S. Blatchley..	John S. Wright..	Donaldson Bodine.....	G. A. Abbott	W. A. McBeth.
1903–1904..	C. L. Mees	John S. Wright...	J. H. Ransom.....	G. A. Abbott ..	W. A. McBeth.

CONSTITUTION.

ARTICLE I.

SECTION 1. This association shall be called the Indiana Academy of Science.

SEC. 2. The objects of this Academy shall be scientific research and the diffusion of knowledge concerning the various departments of science; to promote intercourse between men engaged in scientific work, especially in Indiana; to assist by investigation and discussion in developing and making known the material, educational and other resources and riches of the State; to arrange and prepare for publication such reports of investigation and discussions as may further the aims and objects of the Academy as set forth in these articles.

Whereas, the State has undertaken the publication of such proceedings, the Academy will, upon request of the Governor, or of one of the several departments of the State, through the Governor, act through its council as an advisory body in the direction and execution of any investigation within its province as stated. The necessary expenses incurred in the prosecution of such investigation are to be borne by the State; no pecuniary gain is to come to the Academy for its advice or direction of such investigation.

The regular proceedings of the Academy as published by the State shall become a public document.

ARTICLE II.

SECTION 1. Members of this Academy shall be honorary fellows, fellows, non-resident members or active members.

SEC. 2. Any person engaged in any department of scientific work, or in original research in any department of science, shall be eligible to active membership. Active members may be annual or life members. Annual members may be elected at any meeting of the Academy; they shall sign the constitution, pay an admission fee of two dollars,

and thereafter an annual fee of one dollar. Any person who shall at one time contribute fifty dollars to the funds of this Academy, may be elected a life member of the Academy, free of assessment. Non-resident members may be elected from those who have been active members but who have removed from the State. In any case, a three-fourths vote of the members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on application for membership, who shall consider such application and report to the Academy before the election.

SEC. 3. The members who are actively engaged in scientific work, who have recognized standing as scientific men, and who have been members of the Academy at least one year, may be recommended for nomination for election as fellows by three fellows or members personally acquainted with their work and character. Of members so nominated a number not exceeding five in one year may, on recommendation of the Executive Committee, be elected as fellows. At the meeting at which this is adopted, the members of the Executive Committee for 1894 and fifteen others shall be elected fellows, and those now honorary members shall become honorary fellows. Honorary fellows may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case a three-fourths vote of the members present shall elect.

ARTICLE III.

SECTION 1. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall hold office one year. They shall consist of a President, Vice-President, Secretary, Assistant Secretary, Press Secretary, and Treasurer, who shall perform the duties usually pertaining to their respective offices and in addition, with the ex-Presidents of the Academy, shall constitute an Executive Committee. The President shall, at each annual meeting, appoint two members to be a committee which shall prepare the programs and have charge of the arrangements for all meetings for one year.

SEC. 2. The annual meeting of this Academy shall be held in the city of Indianapolis within the week following Christmas of each year, unless otherwise ordered by the Executive Committee. There shall

also be a summer meeting at such time and place as may be decided upon by the Executive Committee. Other meetings may be called at the discretion of the Executive Committee. The past Presidents, together with the officers and Executive Committee, shall constitute the Council of the Academy, and represent it in the transaction of any necessary business not specially provided for in this constitution, in the interim between general meetings.

SEC. 3. This constitution may be altered or amended at any annual meeting by a three-fourths majority of the attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

BY-LAWS.

1. On motion, any special department of science shall be assigned to a curator, whose duty it shall be, with the assistance of the other members interested in the same department, to endeavor to advance knowledge in that particular department. Each curator shall report at such time and place as the Academy shall direct. These reports shall include a brief summary of the progress of the department during the year preceding the presentation of the report.

2. The President shall deliver a public address on the morning of one of the days of the meeting at the expiration of his term of office.

3. The Press Secretary shall attend to the securing of proper newspaper reports of the meetings and assist the Secretary.

4. No special meeting of the Academy shall be held without a notice of the same having been sent to the address of each member at least fifteen days before such meeting.

5. No bill against the Academy shall be paid without an order signed by the President and countersigned by the Secretary.

6. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the Treasurer, shall have their names stricken from the roll.

7. Ten members shall constitute a quorum for the transaction of business.

MEMBERS.

FELLOWS.

R. J. Aley	*1898	Bloomington.
J. C. Arthur	1893	Lafayette.
George W. Benton	1896	Indianapolis.
A. J. Bigney	1897	Moore's Hill.
A. W. Bitting	1897	West Lafayette.
Donaldson Bodine.	1899	Crawfordsville.
W. S. Blatchley	1893	Indianapolis.
H. L. Bruner	1899	Irvington.
Severance Burrage	1898	Lafayette.
A. W. Butler	1893	Indianapolis.
J. L. Campbell	1893	Crawfordsville.
Mel. T. Cook	1902	Newcastle.
John M. Coulter	1893	Chicago, Ill.
Stanley Coulter	1893	Lafayette.
Glenn Culbertson	1899	Hanover.
D. W. Dennis	1895	Richmond.
C. R. Dryer	1897	Terre Haute.
C. H. Eigenmann	1893	Bloomington.
Percy Norton Evans	1901	West Lafayette.
A. L. Foley	1897	Bloomington.
Katherine E. Golden	1895	Lafayette.
M. J. Golden	1899	Lafayette.
W. F. M. Goss	1893	Lafayette.
Thomas Gray	1893	Terre Haute.
A. S. Hathaway	1895	Terre Haute.
W. K. Hatt	1902	Lafayette.
Robert Hessler	1899	Logansport.
H. A. Huston	1893	Lafayette.
Arthur Kendrick	1898	Terre Haute.
Robert E. Lyons	1896	Bloomington.
V. F. Marsters	1893	Bloomington.
C. L. Mees	1894	Terre Haute.
W. J. Moenkhaus	1901	Bloomington.

*Date of election.

Joseph Moore	*1896	Richmond.
D. M. Mottier	1893	Bloomington.
J. P. Naylor	1903	Greencastle.
W. A. Noyes	1893	Terre Haute.
J. H. Ransom	1902	Lafayette.
L. J. Rettger	1896	Terre Haute.
J. T. Scovell	1894	Terre Haute.
Alex Smith	1893	Chicago, Ill.
W. E. Stone	1893	Lafayette.
Joseph Swain	1898	Swarthmore, Pa.
M. B. Thomas	1893	Crawfordsville.
C. A. Waldo	1893	Lafayette.
F. M. Webster	1894	Champaign, Ill.
H. W. Wiley	1895	Washington, D. C.
John S. Wright	1894	Indianapolis.

NON-RESIDENT MEMBERS.

George H. Ashley	Charleston, S. C.
M. A Brannon	Grand Forks, N. D.
J. C. Branner	Stanford University, Cal.
D. H. Campbell	Stanford University, Cal.
A. Wilmer Duff	Worcester, Mass.
B. W. Everman	Washington, D. C.
Charles H. Gilbert	Stanford University, Cal.
C. W. Green	Stanford University, Cal.
C. W. Hargitt	Syracuse, N. Y.
O. P. Hay	New York City.
Edward Hughes	Stockton, Cal.
O. P. Jenkins	Stanford University, Cal.
D. S. Jordan	Stanford University, Cal.
J. S. Kingsley	Tufts College, Mass.
D. T. MacDougal	Bronx Park, New York City.
T. C. Mendenhall	Worcester, Mass.
Alfred Springer	Cincinnati, Ohio.
L. M. Underwood	New York City.
Robert B. Warder	Washington, D. C.
Ernest Walker	Clemson College, S. C.

*Date of election.

ACTIVE MEMBERS.

George Abbott.....Indianapolis.
Frederick W. Andrews .....Bloomington.
George C. Ashman.....Frankfort.
Edward Ayres.....Lafayette.
Edward Hugh Bangs..... Indianapolis.
Walter D. Baker.....Indianapolis.
Arthur M. Banta.....Franklin.
J. W. Beede.....Bloomington.
William N. Blanchard .....Greencastle.
Edwin M. Blake.....Lafayette.
Lee F. Bennett.....Valparaiso.
Charles S. Bond.....Richmond.
Fred. J. Breeze.....Pittsburg.
E. M. Bruce.....Weston, Oregon.
Herman S. Chamberlain.....Indianapolis.
E. J. Chansler.....Bicknell.
Otto O. Clayton.....Geneva.
Howard W. Clark .....Chicago, Ill.
George Clements .....Springfield, Ill.
Charles Clickener.....Silverwood, R. D. No. 1.
U. O. Cox . .....Mankato, Minn.
William Clifford Cox.....Columbus.
J. A. Cragwall.....Crawfordsville.
Albert B. Crow.....Charleston, Ill.
M. E. Crowell..... .....Franklin.
Edward Roscoe Cumings..... .....Bloomington.
Alida M. Cunningham.....Alexandria.
Lorenzo E. Daniels .....Indianapolis.
H. J. Davidson .....Baltimore, Md.
Charles C. Deam. .....Bluffton.
Martha Doan .....Westfield.
J. P. Dolan ..... Syracuse.
Herman B. Dorner..... .....Lafayette.
Hans Duden .....Indianapolis.
E. G. Eberhardt ..... Indianapolis.
Frank R. Eldred .....Indianapolis.

M. N. Elrod ..... Columbus.
Samuel G. Evans ..... Evansville.
Carlton G. Ferris ..... Big Rapids, Mich.
E. M. Fisher ..... Urmeyville.
Wilbur A. Fisk ..... Richmond.
W. B. Fletcher ..... Indianapolis.
Austin Funk ..... New Albany.
John D. Gabel ..... Montpelier.
Charles W. Garrett ..... Logansport.
Robert G. Gillum ..... Terre Haute.
Vernon Gould ..... Rochester.
Walter L. Hahn ..... Bascom.
Victor Hendricks ..... Indianapolis.
Mary A. Hickman ..... Greencastle.
John E. Higdon ..... Indianapolis.
Frank R. Higgins ..... Terre Haute.
S. Bella Hilands ..... Madison.
John J. Hildebrandt ..... Logansport.
J. D. Hoffman ..... Lafayette.
Allen D. Hole ..... Richmond.
Lucius M. Hubbard ..... South Bend.
John N. Hurty ..... Indianapolis.
C. F. Jackson ..... Greencastle.
Alex. Johnson ..... Ft. Wayne.
Edwin S. Johonnott, Jr ..... Terre Haute.
Ernest E. Jones ..... Kokomo.
Chancey Juday ..... Boulder, Colo.
O. L. Kelso ..... Terre Haute.
Norton A. Kent ..... Crawfordsville.
Charles T. Knipp ..... Bloomington.
Henry H. Lane ..... Lebanon.
William E. Lawrence ..... Richmond.
V. H. Lockwood ..... Indianapolis.
William A. McBeth ..... Terre Haute.
Robert Wesley McBride ..... Indianapolis.
Rousseau McClellan ..... Indianapolis.
Richard C. McClaskey ..... Terre Haute.
Lynn B. McMullen ..... Indianapolis.

Edward G. Mahin.....West Lafayette.
James E. Manchester.....Vincennes.
Clark Mick.....Indianapolis.
W. G. Middleton.....Richmond.
John A. Miller.....Bloomington.
H. T. Montgomery.....South Bend.
Walter P. Morgan.....Terre Haute.
Fred Mutchler.....Terre Haute.
Charles E. Newlin.....Irvington.
John Newlin.....West Lafayette.
John F. Newsom.....Stanford University, Cal.
R. W. Noble.....Chicago, Ill.
D. A. Owen.....Franklin.
Rollo J. Peirce.....Logansport.
Ralph B. Polk.....Greenwood.
James A. Price.....Ft. Wayne.
Frank A. Preston.....Indianapolis.
A. H. Purdue.....Fayetteville, Ark.
Ryland Ratliff.....Bloomington.
Albert B. Reagan.....Rose Bud Agency, S. D.
Allen J. Reynolds.....Peru.
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C. Piper Smith.....Alexandria.
Retta E. Spears.....Elkhart.
J. M. Stoddard.....Indianapolis.
Charles F. Stegmaier.....Greensburg.
William Stewart.....Burlington, Vt.
William B. Streeter.....Indianapolis.
Frank B. Taylor.....Ft. Wayne.
J. F. Thompson.....Richmond.
C. H. Underwood.....Indianapolis.

A. L. Treadwell ..... Oxford, Ohio.
Daniel J. Troyer ..... Goshen.
A. B. Ulrey ..... North Manchester.
W. B. Van Gorder ..... Worthington.
Arthur C. Veatch ..... Rockport.
H. S. Voorhees ..... Ft. Wayne.
J. H. Voris ..... Huntington.
Frank B. Wade ..... Indianapolis.
Daniel T. Weir ..... Indianapolis.
B. C. Waldemaier ..... West Lafayette.
Jacob Westlund ..... Lafayette.
Fred C. Whitcomb ..... Delphi.
William M. Whitten ..... South Bend.
Neil H. Williams ..... Indianapolis.
William Watson Woollen ..... Indianapolis.
J. F. Woolsey ..... Indianapolis.
Lucy Youse ..... Indianapolis.

Fellows	48
Non-resident members	20
Active members	127
Total	195

LIST OF FOREIGN CORRESPONDENTS.

AFRICA.

Dr. J. Medley Wood, Natal Botanical Gardens, Berea Durban, South Africa.

South African Philosophical Society, Cape Town, South Africa.

ASIA.

China Branch Royal Asiatic Society, Shanghai, China.

Asiatic Society of Bengal, Calcutta, India.

Geological Survey of India, Calcutta, India.

Indian Museum of India, Calcutta, India.

India Survey Department of India, Calcutta, India.

Deutsche Gesellschaft, für Natur- und Völkerkunde Ostasiens, Tokio, Japan.

Imperial University, Tokio, Japan.

Koninklijke Naturkundige Vereeniging in Nederlandsch-Indie, Batavia, Java.

Hon. D. D. Baldwin, Honolulu, Hawaiian Islands.

EUROPE.

V. R. Tschusizu Schmidhoffen, Villa Tannenhof, Halle in Salzburg, Austria.

Herman von Vilas, Innsbruck, Austria.

Ethnologische Mittheilungen aus Ungarn, Budapest, Austro-Hungary.

Mathematische und Naturwissenschaftliche Berichte aus Ungarn, Budapest, Austro-Hungary.

K. K. Geologische Reichsanstalt, Vienna (Wien), Austro-Hungary.

K. U. Naturwissenschaftliche Gesellschaft, Budapest, Austro-Hungary.

Naturwissenschaftlich-Medizinischer Verein in Innsbruck (Tyrol), Austro-Hungary.

Editors "Termeszetrajzi Fuzetk," Hungarian National Museum, Budapest, Austro-Hungary.

Dr. Eugen Dadai, Adj. am. Nat. Mus., Budapest, Austro-Hungary.

Dr. Julius von Madarasz, Budapest, Austro-Hungary.
K. K. Naturhistorisches Hofmuseum, Vienna (Wien), Austro-Hungary.
Ornithological Society of Vienna (Wien), Austro-Hungary.
Zoölogische-Botanische Gesellschaft in Wien (Vienna), Austro-Hungary.
Dr. J. von Csato, Nagy Enyed, Austro-Hungary.
Botanic Garden, K. K. Universitat, Wien (Vienna), Austro-Hungary.

Malacological Society of Belgium, Brussels, Belgium.
Royal Academy of Science, Letters and Fine Arts, Brussels, Belgium.
Royal Linnean Society, Brussels, Belgium.
Societé Belge de Geologie, de Paleontologié et Hydrologie, Brussels, Belgium.
Societé Royale de Botanique, Brussels, Belgium.
Societé Geologique de Belgique, Liège, Belgium.
Royal Botanical Gardens, Brussels, Belgium.

Bristol Naturalists' Society, Bristol, England.
Geological Society of London, London, England.
Dr. E. M. Holmes, British Pharm. Soc'y, Bloomsbury Sq., London, W. C., England.
Jenner Institute of Preventive Medicine, London, England.
The Librarian, Linnean Society, Burlington House, Piccadilly, London W., England.
Liverpool Geological Society, Liverpool, England.
Manchester Literary and Philosophical Society, Manchester, England.
"Nature," London, England.
Royal Botanical Society, London, England.
Royal Kew Gardens, London, England.
Royal Geological Society of Cornwall, Penzance, England.
Royal Microscopical Society, London, England.
Zoölogical Society, London, England.
Lieut.-Col. John Biddulph, 43 Charing Cross, London, England.
Dr. G. A. Boulenger, British Mus. (Nat. Hist.), London, England.
F. DuCane Godman, 10 Chandos St., Cavendish Sq., London, England.
Mr. Howard Saunders, 7 Radnor Place, Hyde Park, London W., England.
Phillip L. Sclater, 3 Hanover Sq., London W., England.
Dr. Richard Bowlder Sharpe, British Mus. (Nat. Hist.), London, England.
Prof. Alfred Russell Wallace, Corfe View, Parkstone, Dorset, England.

Botanical Society of France, Paris, France.
Ministérie de l'Agriculture, Paris, France.
Societé Entomologique de France, Paris, France.
L'Institut Grand Ducal de Luxembourg, Luxembourg, Lux., France.
Soc. de Horticulture et de Botan. de Marseille, Marseilles, France.
La Soc. Linneenne de Normandie, Caen, France.
Societé Linneenne de Bordeaux, Bordeaux, France.
Soc. des Naturelles, etc., Nantes, France.
Zoölogical Society of France, Paris, France.
Baron Louis d'Hamonville, Meurthe et Moselle, France.
Pasteur Institute, Lille, France.
Museum d'Histoire Naturelle, Paris, France.

Bontanischer Verein der Provinz Brandenburg, Berlin, Germany.
Deutsche Geologische Gesellschaft, Berlin, Germany.
Entomologischer Verein in Berlin, Berlin, Germany.
Journal für Ornithologie, Berlin, Germany.
Prof. Dr. Jean Cabanis, Alte Jacob Strasse, 103 A., Berlin, Germany.
Augsburger Naturhistorischer Verein, Augsburg, Germany.
Count Hans von Berlspen, Münden, Germany.
Braunschweiger Verein für Naturwissenschaft, Braunschweig, Germany.
Bremer Naturwissenschaftlicher Verein, Bremen, Germany.
Ornithologischer Verein München, Thierschstrasse, 37½, München, Germany.
Royal Botanical Gardens, Berlin W., Germany.
Kaiserliche Leopoldische-Carolinische Deutsche Akademie der Naturforscher, Halle a Saale, Wilhemstrasse 37, Germany.
Königlich-Sächsische Gesellschaft der Wissenschaften, Mathematisch-Physische Classe, Leipzig, Saxony, Germany.
Naturhistorische Gesellschaft zu Hanover, Hanover, Prussia, Germany.
Naturwissenschaftlicher Verein in Hamburg, Hamburg, Germany.
Verein für Erdkunde, Leipzig, Germany.
Verein für Naturkunde, Wiesbaden, Prussia.

Belfast Natural History and Philosophical Society, Belfast, Ireland.
Royal Dublin Society, Dublin.
Royal Botanic Gardens, Glasnevin, County Dublin, Ireland.

Societa Entomologica Italiana, Florence, Italy.
Prof. H. H. Giglioli, Museum Vertebrate Zoölogy, Florence, Italy.
Dr. Alberto Perngia, Museo Civico di Storia Naturale, Genoa, Italy.
Societa Italiana de Scienze Naturali, Milan, Italy.
Societa Africana d'Italia, Naples, Italy.
Dell' Academia Pontifico de Nuovi Lincei, Rome, Italy.
Minister of Agriculture, Industry and Commerce, Rome, Italy.
Rassegna della Scienze Geologiche in Italia, Rome, Italy.
R. Comitato Geologico d'Italia, Rome, Italy.
R. Comitato Geologico d'Italia, Rome, Italy.
Prof. Count Tomasso Salvadori, Zoölog. Museum, Turin, Italy.

Royal Norwegian Society of Sciences, Throndhjem, Norway.
Dr. Robert Collett, Kongl. Frederiks Univ. Christiana, Norway.

Academia Real des Sciencias de Lisboa (Lisbon), Portugal.
Comité Geologique de Russie, St. Petersburg, Russia.
Imperial Academy of Sciences, St. Petersburg, Russia.
Imperial Society of Naturalists, Moscow, Russia.
Jardin Imperial de Botanique, St. Petersburg, Russia.
The Botanical Society of Edinburgh, Edinburgh, Scotland.
John J. Dalgleish, Brankston Grange, Bogside Sta., Sterling, Scotland.
Edinburgh Geological Society, Edinburgh, Scotland.
Geological Society of Glasgow, Scotland.
John A. Harvie-Brown, Duniplace House, Larbert, Stirlingshire, Scotland.
Natural History Society, Glasgow, Scotland.
Philosophical Society of Glasgow, Glasgow, Scotland.
Royal Society of Edinburgh, Edinburgh, Scotland.
Royal Physical Society, Edinburgh, Scotland.
Royal Botanic Garden, Edinburgh, Scotland.

Barcelona Academia de Ciencias y Artes, Barcelona, Spain.
Royal Academy of Sciences, Madrid, Spain.

Institut Royal Geologique de Suède, Stockholm, Sweden.
Societé Entomologique a Stockholm, Stockholm, Sweden.
Royal Swedish Academy of Science, Stockholm, Sweden.

Naturforschende Gesellschaft, Basel, Switzerland.
Naturforschende Gesellschaft in Berne, Berne, Switzerland.
La Societé Bontanique Suisse, Geneva, Switzerland.
Societé Helvetique de Sciences Naturelles, Geneva, Switzerland.
Societé de Physique et d'Historie Naturelle de Geneva, Geneva, Switzerland.
Concilium Bibliographicum, Zürich-Oberstrasse, Switzerland.
Naturforschende Gesellschaft, Zürich, Switzerland.
Schweizerische Botanische Gesellschaft, Zürich, Switzerland.
Prof. Herbert H. Field, Zürich, Switzerland.

AUSTRALIA.

Linnean Society of New South Wales, Sidney, New South Wales.
Royal Society of New South Wales, Sidney, New South Wales.
Prof. Liveridge, F. R. S., Sidney, New South Wales.
Hon. Minister of Mines, Sidney, New South Wales.
Mr. E. P. Ramsey, Sidney, New South Wales.
Royal Society of Queensland, Brisbane, Queensland.
Royal Society of South Australia, Adelaide, South Australia.
Victoria Pub. Library, Museum and Nat. Gallery, Melbourne, Victoria.
Prof. W. L. Buller, Wellington, New Zealand.

NORTH AMERICA.

Natural Hist. Society of British Columbia, Victoria, British Columbia.
Canadian Record of Science, Montreal, Canada.
McGill University, Montreal, Canada.
Natural Society, Montreal, Canada.
Natural History Society, St. Johns, New Brunswick.
Nova Scotia Institute of Science, Halifax, N. S.
Manitoba Historical and Scientific Society, Winnipeg, Manitoba.
Dr. T. McIlwraith, Cairnbrae, Hamilton, Ontaria.
The Royal Society of Canada, Ottawa, Ontario.
Natural History Society, Toronto, Ontario.
Hamilton Association Library, Hamilton, Ontario.
Canadian Entomologist, Ottawa, Ontario.
Department of Marine and Fisheries, Ottawa, Ontario.
Ontario Agricultural College, Guelph, Ontario.

Canadian Institute, Toronto.
Ottawa Field Naturalists' Club, Ottawa, Ontario.
University of Toronto, Toronto.
Geological Survey of Canada, Ottawa, Ontario.
La Naturaliste Canadian, Chicontini, Quebec.

La Naturale Za, City of Mexico.
Mexican Society of Natural History, City of Mexico.
Museo Nacional, City of Mexico.
Sociedad Cientifica Antonio Alzate, City of Mexico.
Sociedad Mexicana de Geographia y Estadistica de la Republica Mexicana, City of Mexico.

WEST INDIES.

Botanical Department, Port of Spain, Trinidad, British West Indies.
Victoria Institute, Trinidad, British West Indies.
Museo Nacional, San Jose, Costa Rica, Central America.
Dr. Anastasia Alfaro, Secy. National Museum, San Jose, Costa Rica.
Rafael Arango, Havana, Cuba.
Jamaica Institute, Kingston, Jamaica, West Indies.
The Hope Gardens, Kingston, Jamaica, West Indies.

SOUTH AMERICA.

Argentina Historia Natural Florentine Amegline, Buenos Ayres, Argentine Republic.
Musée de la Plata, Argentine Republic.
Nacional Academia des Ciencias, Cordoba, Argentine Republic.
Sociedad Cientifica Argentine, Buenos Ayres.
Museo Nacional, Rio de Janeiro, Brazil.
Sociedad de Geographia, Rio de Janeiro, Brazil.
Dr. Herman von Jhering, Dir. Zoöl. Sec. Con. Geog. e Geol. de Sao Paulo, Rio Grande do Sul, Brazil.

Deutscher Wissenschaftlicher Verein in Santiago, Santiago, Chili.
Societé Scientifique du Chili, Santiago, Chili.
Sociedad Guatemalteca de Ciencias, Guatemala, Guatemala.

PROGRAM

OF THE

NINETEENTH ANNUAL MEETING

OF THE

INDIANA ACADEMY OF SCIENCE,

STATE HOUSE, INDIANAPOLIS,

December 28 and 29, 1903.

OFFICERS AND EX-OFFICIO EXECUTIVE COMMITTEE.

W. S. BLATCHLEY, President. C. L. MEES, Vice-President. JOHN S. WRIGHT, Secretary.
DONALDSON BODINE, Assistant Secretary. G. A. ABBOTT, Press Secretary.
W. A. MCBETH, Treasurer.

H. W. WILEY,	STANLEY COULTER,	T. C. MENDENHALL,
M. B. THOMAS,	AMOS W. BUTLER,	JOHN C. BRANNER,
D. W. DENNIS,	W. A. NOYES,	J. P. D. JOHN,
C. H. EIGENMANN,	J. C. ARTHUR,	JOHN M. COULTER,
C. A. WALDO,	J. L. CAMPBELL,	DAVID S. JORDAN.
THOMAS GRAY,	O. P. HAY,	

With one exception, the sessions of the Academy will be held in the State House, in the rooms of the State Board of Agriculture and Horticulture; the President's address will be given in the auditorium of the Shortridge High School.

Headquarters will be at the English Hotel. A rate of $2.00 and up per day, American plan, will be made to all persons who make it known at the time of registering that they are members of the Academy.

Reduced railroad rates for the members can not be secured under the present ruling of the Traffic Association. Many of the colleges can secure special rates on the various roads. Those who can not do this, could join the State Teachers' Association, whose sessions begin on December 29, and thus secure a one-and-one-third round-trip fare.

PROGRAM COMMITTEE.

MEL. T. COOK, Greencastle, Indiana. GLENN CULBERTSON, Hanover, Indiana.

GENERAL PROGRAM.

MONDAY, DECEMBER 28.

Meeting of Executive Committee at Hotel Headquarters ..... 10:30 a. m.
General Session followed by Sectional Meetings ..... 2 p. m. to 5 p. m.
President's Address, Shortridge High School ..... 8 p. m.
If advisable, the President's Address may be followed by a short session.

TUESDAY, DECEMBER 29.

General Session, followed by Sectional Meetings ..... 9 a. m. to 12 m.

LIST OF PAPERS TO BE READ.

ADDRESS BY THE RETIRING PRESIDENT,

WILLIS S. BLATCHLEY,

At 8 o'clock Monday evening, at Shortridge High School.

Subject: "The Indiana of Nature; Its Evolution."

The following papers will be read in the order in which they appear on the program, except that certain papers will be presented "*pari passu*" in sectional meetings. When a paper is called and the reader is not present, it will be dropped to the end of the list, unless by mutual agreement an exchange can be made with another whose time is approximately the same. Where no time was sent with the papers, they have been uniformly assigned ten minutes. Opportunity will be given after the reading of each paper for a brief discussion.

N. B.—By the order of the Academy, no paper can be read until an abstract of its contents or the written paper has been placed in the hands of the Secretary.

GENERAL.

1. "Colds" and Cold, 10m.....Robert Hessler
2. A Prehistoric Fortification near Madison, Indiana, 5m..... ..... Glenn Culbertson
3. The Apache Stick Game, 10m.....Albert B. Reagan
4. Some Paintings from one of the Estufas in the Indian Village of Jemez, New Mexico, 10m.....Albert B. Reagan

*5. Notes on the Caves of Cuba.....J. W. Beede

6. What Bacteriology has done for Sanitary Science, 10m..... ..... Severance Burrage
7. Conditions affecting the distribution of Birds in Indiana, 20m. .....Amos W. Butler

PHYSICS, CHEMISTRY AND GEOLOGY.

8. A new problem in Hydrodynamics with Extraneous Forces Acting, 10m.....E. L. Hancock
9. On the use of Nickel in the core of the Marconi Magnet Director, 10m.....Arthur L. Foley

*10. Effect of Ultraviolet Light on the action of the Coherer, 10m. .....Arthur L. Foley

*11. The Life of Radium, 5m.....Arthur L. Foley

12. The Edison effect in a "Hylo" Lamp, 10m.....Arthur L. Foley
13. On the use of MnO_2 in the generation of O from $KClO_3$, 5m. .....R. R. Ramsey, Arthur L. Foley

*14. A Method of Determining the Absolute Dilation of Mercury, 5m., ...Arthur L. Foley.

*Paper not presented.

15. Geology of the Fort Apache Region, Arizona, (by title).....
.....Albert B. Reagan
16. Geology of Monroe County, Indiana, North of the Latitude of Bloomington .....Albert B. Reagan
17. What is the Age of the Aubery Limestone of the Rocky Mountains? .....Albert B. Reagan
*18. Some Fossils from the Lower Aubery and Upper Red Wall in the Vicinity of Fort Apache, Arizona.....Albert B. Reagan
19. The Fossils of the Red Wall Compared with Those of the Kansas Coal Measures, 10m.....Albert B. Reagan
20. Double Salts in Solution, 10m.....P. N. Evans
21. Ionic Friction, 10m.....P. N. Evans
22. A Topographic Result of the Alluvial Cone, 10m.....A. H. Purdue
23. A Note on the Radio-Activity of Strontium-Salicylate, 10m.....
.....J. F. Woolsey
24. Progress in Locomotive Testing, 10m.....W. F. M. Goss

BOTANY AND ZOOLOGY.

25. A Note on the Breeding Habits of the Common or White Sucker, 3m.....Glenn Culbertson
26. Additions to the Flora of Indiana, 8m.....H. B. Dorner
27. Additions to the List of Gall-Producing Insects Common to Indiana, 5m.....Mel. T. Cook
28. Botanical Notes, 10m .....M. N. Elrod
29. Bird Notes from the Indiana State Forestry Reservation.....
.....Chas. Piper Smith
30. Notes Upon Some Little Known Members of the Indiana Flora, 10m .....Chas. Piper Smith
31. The Development of the Spermatozoid of Chara, 10m..D. M. Mottier
32. Further Studies on Anomalous Dicotyledonous Plants, 10m.....
.....D. M. Mottier
33. A Crow Roost near Richmond, Indiana, 5m.....
.....D. W. Dennis and W. E. Lawrence
34. A New Adjustable Stand for Physiological Apparatus and Modifications in other Physiological Devices, 10m.....
.....J. F. Woolsey and John S. Wright
35. An Abnormality in the Nut of Hicoria ovata, 5m....John S. Wright

*Paper not presented.

*36. Contribution to the Flora of Indiana, No. VIII, 10m..Stanley Coulter
*37. On the Germination of Certain Native Weeds, 10m..Stanley Coulter
38. Revised list of Indiana Plant Rusts, 10m.....J. C. Arthur
*39. Cuban Notes, 10m.....C. H. Eigenmann
40. Ecological Notes on the Mussels Winona Lake, 10m...T. J. Headlee
41. Ecological Notes on the Birds occurring within a radius of 5 miles of the Indiana University Campus (with photographs by G. C. Littell), 10m.....Waldo L. McAtee
*42. List of Mammals, Reptiles and Batrachians of Monroe County, Indiana, 10m.....Waldo L. McAtee
43. Birds Nests of an Old Apple Orchard near Indiana University Campus, 10m.....Gertrude Hitze
44. Nerve end organ in the Pancreas, 5m.....E. O. Little
45. Discoidal Pith in our Woody Plants, 5m.....F. W. Foxworthy
46. New Science Laboratory, Moores Hill College, 5m.....A. J. Bigney
47. The Sun or Gunelpiya Medicine Disk.....Albert B. Reagan

THE NINETEENTH ANNUAL MEETING OF THE INDIANA ACADEMY OF SCIENCE.

The nineteenth annual meeting of the Indiana Academy of Science was held in Indianapolis, Monday and Tuesday, December 28 and 29, 1903.

Monday 10:45 a. m., the Executive Committee met in session at hotel headquarters.

At 2 o'clock p. m. President Willis S. Blatchley called the Academy to order in general session in the room of the State Board of Agriculture, State House. The transaction of routine and miscellaneous business occupied the first part of the session. Following this, papers of general interest were read and discussed. After the disposition of these, special technical subjects occupied the time until adjournment at 5 p. m

The address of the retiring President, Willis S. Blatchley, was delivered in the auditorium of the Shortridge High School at 8 p. m., before the members of the Academy and a number of invited guests, subject—"The Indiana of Nature; its Evolution."

*Paper not presented.

Tuesday 29, 9 a. m., the Academy met in general session before which the remaining papers of the program were read and discussed. Following the disposition of the papers unfinished business was considered.

Adjournment.

THE FIELD MEETING OF 1903.

The field meeting of 1903 was held in Madison and Hanover, Thursday and Friday, May 21 and 22. Thursday evening a well attended public session was held in the auditorium of the Madison High School; the program consisted of musical numbers and addresses. President W. S. Blatchley spoke on the mineral fuels of the State and Dr. Stanley Coulter on forestry work in Indiana. After the adjournment of the public session a short business meeting was held in the Madison Hotel.

At 8:30 a. m., Friday the 22d, the members left hotel headquarters for the field, proceeding by carriages over the Hanover road to the mouth of the gorge which leads to Clifty Falls. The remainder of the trip to the Falls was made on foot over territory of great interest to naturalists, especially to geologists and botanists. Clifty Falls was reached about noon. Luncheon was served here, after which a cross-country drive was made to Hanover College. The remainder of the afternoon was spent in viewing the college buildings and equipment, and in enjoying the magnificent scenery of the vicinity. At 6 o'clock dinner the visiting members of the Academy were guests in the homes of the members of the Hanover College faculty.

At 8 o'clock a public meting was held in the college chapel, addresses were made by Drs. Stanley Coulter, J. C. Arthur, M. T. Cook, N. A. Kent and A. F. Foerste. After this session an enjoyable reception was tendered the Academy at the home of President Fisher. The return to Madison was made that night, after which a very brief business meeting was held in the hotel headquarters. Adjournment, 12 o'clock, midnight, Friday, May 22.

The spring meeting of 1903 will be remembered as one of the most successful and enjoyable in the history of the Academy. The weather was delightful and the locality interesting from every standpoint. The Academy gratefully acknowledges its obligations to the Madison Commercial Club and to the members of the Hanover College faculty, especially to Professor Culbertson, for their generosity and thoughtful courtesies which anticipated every want of the excursionists.

PRESIDENT'S ADDRESS.

The Indiana of Nature; Its Evolution.

By W. S. Blatchley.

Afar out in the limitless realms of space a planet moves—propelled onward by an unseen, uncontrollable force around its parent orb, a sun. For millions, perhaps billions, of years, as man counts time, that planet has moved in the same pathway, meanwhile undergoing most wonderful changes in bulk and form. At first a vast, irregular mass of burning, gaseous matter, thrown off from that sun about which it still revolves, the planet gradually cooled, condensed, and assumed a spheroidal form. Its gaseous elements rearranged themselves to form new compounds, at first liquid, then solid, until in time it came to be a solid globe, or at least one with a solid but uneven crust. The processes of cooling and contraction still continued. The ocean of vapor which formed a large portion of the atmosphere about the planet condensed and fell and formed an ocean of water which filled the depressions in its crust. Above the rim of this ocean there showed in places large areas of land—bare igneous rock, absolutely devoid of life—as, for millions of years, the temperature of both rock and ocean remained too high for living things.

When the mean temperature of its oceanic waters by continued and oft repeated evaporation, cooling and condensation, was reduced to about 150° (degrees) F., there occurred the grandest event in the history of that planet. *In some unknown, unknowable manner, Life came to be.* Within the waters of its ocean there was brought about a combination of matter—a living thing—which could take from the water and from the air above certain elements, and by their aid increase in size and reproduce its kind. The first lowly parasites upon the face or surface of the planet were thus aquatic plants—algæ, fungi and kindred forms. In the course of ages there evolved from them other and higher plants which could live on land; for the decay and erosion of the igneous rocks, added to the remains of the aquatic plants thrown upon the beaches of the ocean, produced a soil from which the higher land plants could derive a part of their nourishment. As the centuries and the æons rolled by, the plants—true parasites that they were—found their way to every part of the planet's

surface. Onto the tops of the loftiest mountains, into the abysses of the deepest oceans, they made their way; their province being the conversion of inorganic matter—earth, air, water—into a form of food suitable to the needs of a higher type of parasite which meanwhile was coming into existence upon the planet's surface. For, as the temperature of the ocean gradually decreased, the Era of Animal Life was ushered in.

The first animals on the planet were also lowly aquatic forms—scarcely differing from the first plants, but possessing a freedom of motion which enabled them to procure a better supply of air and water. Then, evolving into higher and more varied forms as they became adapted to new environments, they spread far and wide through ocean's depths and over plain and mountain, until the whole surface of the planet was peopled, too, by them. But, ever and always, from the time the first animal came to be upon that planet, until the last one finally disappears into the darkness of everlasting night, the *growth* of animal life will depend upon *living food* prepared by the plant—the *motion* of animal life upon *energy* stored within the cells of the plant.

That sun, which in the beginning first cast off the matter of which the planet is formed, still controls it—still rules over it and its destinies with an iron will. Both plant and animal parasite must forever bow before its power. Of the vast floods of energy which stream forth from that sun's disk, in the form of heat and light, an insignificant fraction falls upon the surface of its satellite. Of the minute portion that the planet thus arrests, an equally insignificant part is caught up by its plants and used directly in their growth. Yet the entire productive force of the living portion of that planet turns on this insignificant fraction of an insignificant fraction.

The vegetable cell is thus a storer of power—a reservoir of force. It mediates between the sun—the sole fountain of energy—and the animal life on the planet. The animal can not use an iota of power that some time, either directly or indirectly, has not been stored in the plant cell. Thus, of the two great groups of parasites upon the surface of the planet, the plant must, perforce, have preceded the animal.

For thousands of centuries each type of animal and plant parasite upon that planet was content if it could secure food enough to reach maturity and then a mate to reproduce its kind. All the energies put forth —all the variations in organ and form—all the adaptations to modified environment—were but means toward the better accomplishment of these

two ends. Sometimes a type would reach a culmination or highest point, beyond which it could not advance. Then a degeneration would occur along side lines, or, in many instances, even total extinction of the race or group. Finally, after the planet was hoary with age, a race of animal parasites evolved from the lower forms, whose variations were ever concentrated toward the head or cephalic region. During untold ages their brains slowly but surely increased in size until, in time, they became possessed of the power of reason and of abstract thought. In that age the "prince of parasites" was born. From then on he began to rule not only the other animal and plant parasites about him, but to discover and control the powerful forces of nature, heretofore wholly latent. As he grew in brain power, he grew in greed, in egoism. He came to think that the planet, on which he was but a parasite, was created for him alone; that all other plants and animals were put there for his especial benefit, though many of them out-dated him by millions of years. He began to modify the surface of the planet in all ways possible—to change, as it were, its every aspect to conform to his ideas. He imagined, vain creature that he was, that he could improve upon the works of Nature. In time he divided up the entire land surface of the planet by using sometimes imaginary lines and again natural boundaries. Acres and sections, townships and counties, states and republics, kingdoms and empires were the terms he used to denote his subdivisions, and over all lands, and even seas, he proclaimed himself chief ruler. For that planet is the earth. That "prince of parasites" is Man.

To 36,350 square miles of the earth's surface, lying between the imaginary lines 37° 41′ and 41° 46′ north latitude, and between 84° 44′ and 88° 6′ west longitude, man, in time, gave the name "Indiana." How came this area to be where it is? Of what kind of matter is its surface composed? What was its condition at the time of the advent of the white race? These are questions which should be of interest to every resident of the Hoosier State.

The oldest known rocks on the American continent are those of Archæan Time laid down during the Azoic or lifeless æon of the earth. They are known as the Laurentian System of Rocks and consist mainly of coarse granites, thick-bedded gneisses and syenites, serpentines, schists and beds of modified sandstones, limestones and clays. They were formed from the debris of other rocks still older than themselves; these in their turn having been derived ages ago from those original igneous or

primary rocks whose molten sands rose first above the boiling floods and cooled and crusted into a chaotic continent. For Archæan time comprised those millions of years which elapsed while the crust of the earth was cooling down to a point where life was possible.

The Laurentian rocks are thus devoid of fossils or contain only the remains of the simplest aquatic forms. In North America they comprise the surface of a vast, V-shaped area of 2,000,000 or more square miles which lies, filled with wild lakes, pine clad, rugged, almost impassable, spread in savage sleep from Labrador to the Arctic Ocean. This area embodies the general form of the North American continent and was the nucleus of all the land which was afterward added to it. From these old Laurentian rocks came the debris and sediment which was laid down in the bed of a shallow ocean to form the first rocks comprising the surface of what is now "Indiana."

At the close of the Azoic or Lifeless æon, during which the Laurentian rocks were formed, the Paleozoic or "Æon of Ancient Life" was ushered in. At its beginning the entire area of what is now known as Indiana was covered by a broad ocean which stretched far away to the southwest, while to the north and northeast it extended beyond the present sites of the Great Lakes. This ocean is known to geologists as the "Interior Paleozoic Sea." Into it was carried the sediment derived from the erosion and destruction of the old Laurentian rocks by water and air, which agencies then, as now, were ever at work. The Potsdam sandstone of the Cambrian era, which probably underlies the Trenton limestone of the Lower Silurian beneath the greater portion, if not all, of Indiana, was one of the first strata to be laid down in this sea. But as none of the surface of Indiana is represented by the Potsdam stone, it will be passed with this mere mention.

Following the Cambrian came the second grand sub-division of Paleozoic Time, the so-called Lower Silurian or Ordovician Age. At its beginning the sea covering Indiana and the area to the north and east was of course more shallow, as 1,000 feet or more of Potsdam sandstone had been deposited on its floor. The first great stratum of Ordovician rock to be laid down in this sea which is of interest to us was the Trenton limestone, which, during the past two decades, has become so noted in Indiana as the source of natural gas and crude petroleum.

It is a well known geological fact that most, if not all, limestones owe their origin to the presence of minute organisms in the water in which

the limestone was formed. The animals from whose remains the Trenton limestone was, for the most part, derived, were probably very low forms —the polyps and bryozoans of the ancient Silurian seas. In untold numbers they existed, and the carbonate of lime, which makes up 80 per cent. of the unmodified Trenton rock, is largely the remains of their secretions and incrustations. Associated with these lower forms were myriads of higher ones—crinoids, brachiopods, trilobites, gastropods and even fishes. The presence of such swarms of animal life made necessary the existence of an abundance of plants; since the plant must ever precede the animal and gather for the latter the energy, and form for it the food—the living protoplasm—necessary to its existence. These plants were mostly marine algae or seaweeds and fucoids, though doubtless many other forms existed of which no remains have been preserved in the rocks of that age.

The Trenton limestones were evidently formed in rather clear waters, at moderate depths. Near the bottoms of these shallow seas great beds of calcareous sediment were gradually collected, and were swept to and fro by the tides and currents. Rivers from the older Cambrian rocks brought down their eroded particles and added to the thickness of the ocean floor. Within these beds of sediment both plants and animals found a grave—their bodies in vast numbers being buried beneath the slowly accumulating deposits of centuries. Once buried in such deposits, they did not decay, as do animals on land, because by the waters above and the calcareous ooze around them, they were shut off from free oxygen, which is the chief agent in decay. Gradually this ooze or fine sediment was, by the agency of the sea water, cemented and consolidated into limestone. In this manner that great layer of Trenton rock which underlies at variable depths the whole of Indiana, was formed. From it has been derived, directly or indirectly, more wealth than from any other one formation, either underlying or forming a portion of the surface of the State.

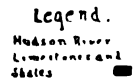
In time the waters of the ocean containing this vast stratum of Trenton limestone, with its enclosed accumulations of undecayed plants and animals, became turbid, and instead of calcareous sediment, deposited mud and clayey sediment in thick beds on top of the limestone strata. These deposits of mud and silt were afterward, by later deposits, compressed into the fine-grained, impervious Utica shale, 100 to 300 feet in thickness, which thus effectually sealed the Trenton limestones and so

retained within them the oil and gas derived from their enclosed organic remains. This oil, and its more volatile portion, the natural gas, was not formed in a short time, but is the result of a slow decomposition or destructive distillation, carried on through thousands of centuries. Accumulating in vast reservoirs—the more porous portions of the Trenton limestone or mother rock—it there remained until man came with his iron drill and furnished a vent through which it could rise. Then by combustion he caused it to yield up the stored energy, conserved since the sun's rays fell on the plants of the old Silurian seas.

After the Utica shale had been laid down as a thick, impervious cover above the Trenton limestone, there followed the Hudson River epoch during which 200 to 600 feet of alternating beds of shale and limestone were deposited in the old sea bottom where now is Indiana. These form the uppermost division of the Lower Silurian age. During the myriads of years necessary to their deposition marine forms were excessively abundant and the advancement in the scale of animal life was correspondingly great. All the principal groups of marine invertebrates which came into existence during the Trenton epoch were represented, but the species were widely different. In addition to life in the sea, there came also to be life on land. Acrogenous plants—forerunners of the ferns and mosses—harbingers of the vast forests of future centuries—came into being along the moist waterways of the growing continent, while insects, the first winged creatures, began to traverse the air.

As yet no part of Indiana was above old ocean's level, but at the close of the Ordovician, after the Hudson River limestones and shales had been laid down, a great upheaval, caused by some subterranean force, brought above the sea a large island of Ordovician rock which ever since has been dry land. This upheaval was greatest over the point where Cincinnati, Ohio, is now located, and the "Cincinnati Uplift" is the name given by geologists to the island and the broad belt of shallowly submerged land which extended from its northern shore in a northwesterly direction, diagonally across the area of the future Indiana. The main portion of that island comprised the southwestern corner of what is now Ohio and a part of northeastern Kentucky. It also included a small part of what is now Indiana and formed the first and oldest portion of the surface of our State. The area whose surface rocks belong to this Hudson River formation comprises part or all of Wayne, Union, Fayette, Franklin, Dearborn, Ripley, Ohio, Switzerland and Jefferson counties.

Over this area the exposed rocks are composed of a series of bluish, thin-bedded limestones intercalated with bluish-green limey shales, while at the top are massive sandy limestone beds of a brownish color The shales are soft, easily weathered and very fossiliferous, while the bluish lime-



INDIANA
at the Close of
Lower Silurian Time.

stones are in places largely composed of fossils. As a part of an island, therefore, upheaved from the Ordovician seas, was the first born land of Indiana; and to that little corner all other portions of our noble State were added in their turn by the workings of nature's forces during after ages.

At the end of the Ordovician or beginning of the Upper Silurian age, the Interior Paleozoic Sea had greatly diminished in area. A broad belt of land had been added to the southern border of the old Laurentian crest, especially over what is now Wisconsin and a portion of northern Illinois; while, extending from what is now Labrador down to Georgia, was another broad belt, following the general trend of the present Alleghany mountains. By the raising of several large islands above its surface at the time of the Cincinnati Uplift, aided by the broad belt of shallowly submerged land already noted, the area of the Interior Sea was still further diminished and to that portion covering what is now the northeastern part of Indiana and the greater part of Ohio, West Virginia, New York and Pennsylvania, the name of "Eastern Interior Sea" is given. This was simply a great bay or eastward extension of a greater "Central Interior Sea" which, at that period, covered most of Indiana, southern Michigan, Illinois and a large portion of the present United States west of the Mississippi River. The most northeastern limits of the Eastern Interior Sea were the present sites of Albany and Troy, New York. The rock-making material which was deposited on the floor of both it and the Central Interior Sea was derived in part from the land along their borders, but mainly from the limey secretions of the life within their waters. The dry land draining into them was small in area and hence there were only small streams for the supply of sediments. Yet, in the course of countless years, sufficient material was deposited to form the thick layer of Niagara limestone which now forms the surface rock over much of northern and eastern Indiana.

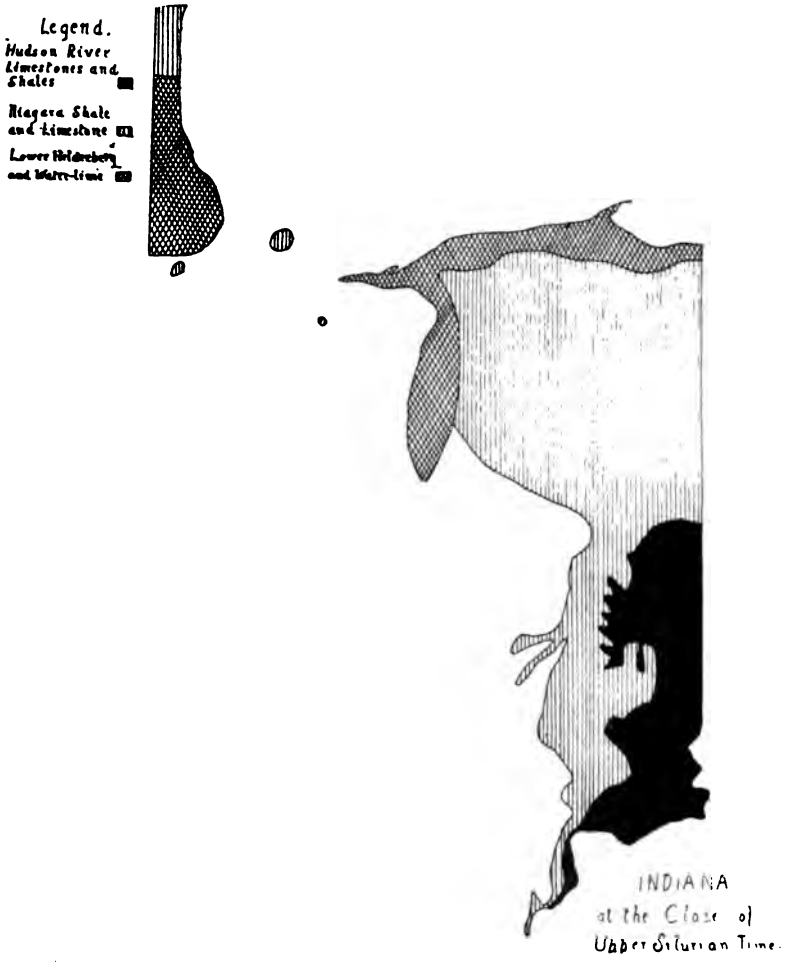
The epochs of the Upper Silurian age, as represented in Indiana, are three in number, viz., the Clinton, the Niagara and the Water Lime, or Lower Helderberg. Each is represented by its characteristic rocks, bearing the peculiar fossils of its time. The Clinton epoch is represented in the State by a close-grained, salmon-colored limestone, varying in thickness from a few inches only to about seven feet. It outcrops in a very narrow strip along the western edge of the area of the Hudson River limestone, already mentioned as the oldest rock in Indiana, and overlies that formation beneath the surface of at least the eastern third of the State. It has no economic importance and serves only as a line of demarcation separating the older Silurian rocks from those great beds of Niagara limestone which were afterward laid down in the Upper Silurian seas.

At the beginning of the Niagara epoch the waters of the Central and Eastern Interior Seas were laden with sediment and beds of bluish-green shales, known as the Niagara shales, and varying in thickness from two to forty feet, were first laid down. Owing to gradual changes in the level of the sea bottom, and a consequent shifting of its tides and currents a clearer, deeper water then resulted, within whose depths there existed life of great variety. Corals and bryozoans were especially represented, and from their remains and those of other marine forms were gradually constructed those beds of gray and buff Niagara limestone, varying in thickness from 100 feet along the Ohio River to 440 feet in the northern and northwestern portions of the State.

Near the close of the Niagara epoch a gradual uprising of a portion of the Eastern and Central Interior Seas took place. From their bottoms there emerged a long peninsula-like strip of land, whose general trend was northwest and southeast. In the former direction it was imperfectly attached to those portions of Wisconsin and Illinois which had come into existence during the Ordovician era. At its lower extremity it merged with that old island of the Cincinnati Uplift which had formed the first land of our present State. The surface rocks of the northwestern corner of Indiana, a narrow and probably interrupted strip extending diagonally across the State, a wide area in the central third and a narrower southern prolongation along the western border of the pre-existing Hudson River group, were thus, for the first time, brought above the level of the sea.

It appears that the force which caused this upraising of the Niagara sea floor was more pronounced at certain points than at others, and so caused a number of dome-like ridges or crests resembling true upheavals in the Niagara beds. These domes are present in an area extending from the Illinois line in Newton County, through the Upper Wabash Valley nearly to the Ohio line, being especially prominent near Wabash, Delphi, Monon, Kentland and other points in the region mentioned. In them the Niagara strata, elsewhere nearly horizontal, are strongly tilted and show other evidence of a true upheaval. These domes were at first probably small islands whose crests remained permanently above the surrounding sea. They thus formed, for a long period, a more or less broken or interrupted connection between the larger area of the Niagara to the southeast and that area in northwestern Indiana which was from now on a part of the continent proper.

The Water Lime and Lower Helderberg are two closely related limestones of the Upper Silurian age which, in Indiana, so merge as to be difficult to distinguish. They represent an epoch between that of the Niagara limestone and the lowest or oldest rocks of the Devonian era.



Their texture and composition shows them to have been laid down in very shallow seas close into the shores of the recently upraised Niagara limestone. The Water Lime is an impure magnesian hydraulic rock, ranging in thickness in Indiana from 20 to 90 feet. It outcrops near Kokomo

where have been found numerous fine examples of its most characteristic fossils—gigantic crustaceans, two feet or more in length, closely related to the king crabs of the present seas. Over the extensive mud flats of the closing period of Upper Silurian time they were the undoubted rulers, while in the nearby waters sported descendents of those mail-clad fishes which first appeared in the Trenton period of the Lower Silurian era.

The Lower Helderberg represents the final epoch of Upper Silurian time. In Indiana its rocks form a buff to gray cherty limestone, 25 to 250 feet in thickness and often irregular and uneven in its bedding. It directly overlies the Niagara limestone where the Water Lime is absent. Outcrops occur at Logansport and other points to the northwest, and drill holes sunk for oil and gas show that it probably forms a portion of the surface rock beneath the deep drift-covered area of the northern third of the State.

The advance in life during the Upper Silurian era was not proportionally as great as that of the preceding age. The earliest of Arachnids, the scorpions, came to be, their first remains being in the Water Lime, showing that they were neighbors of the giant Eurypterid crustaceans. Cockroaches and progenitors of dragonflies were also present, but remains of other terrestrial forms are few or lacking. Among marine invertebrates, Cephalopods reached the acme of their development, the gigantic Orthoceratites of this group, whose remains are so common in the Niagara limestones of Wabash and adjoining counties, being worthy of especial mention.

We have seen that by the beginning of the Devonian Age or Era, which succeeded that of the Upper Silurian, the waters of that great bay known as the Eastern Interior Sea, had become farther separated from those of the Central Interior Sea by the uprising of the Niagara limestone area of eastern Indiana and western Ohio, and also by the deposition along the margin of this formation of the sediment comprising the Water Lime and Lower Helderberg limestones. A probable connection still existed between the waters of these two basins across the broken or interrupted strip connecting the main body of Niagara limestone in eastern Indiana with the main land area of the same formation in northwestern Indiana and northern Illinois.

The Devonian rocks of Indiana may be roughly classed as representing two great epochs, the Corniferous and the Genesee, the former being represented by beds of more or less pure limestone, ranging up to 55

feet in thickness; the latter by beds of black or brownish bituminous shales, which reach a known maximum thickness of 195 feet. The waters in which the materials of the Corniferous limestone were deposited were clear and comparatively pure, and in them sponges, corals, crinoids, trilobites and lower animal forms existed in great profusion. From the lime secreted by these marine forms the upper and purer beds of the Corniferous rock are mainly composed. The great abundance of coral life during the period is grandly shown at the Falls of the Ohio, opposite Louisville, Kentucky, where the Corniferous beds have a notable outcrop. Here "the corals are crowded together in great numbers, some standing as they grew, others lying in fragments, as they were broken and heaped up by the waves; branching forms of large and small size being mingled with massive kinds of hemispherical and other shapes. Some of the cup corals are six or seven inches across at the top, indicating a coral animal seven or eight inches in diameter. Hemispherical compound corals occur, five or six feet in diameter. The various coral-polyps of the era had, beyond doubt, bright and varied coloring like those of the existing tropics; and the reefs formed therefore a brilliant and almost interminable flower garden."

Near the close of the Corniferous epoch deposits of silt, mud and sand began to becloud the clear waters and put an end to the life of many marine forms. The upper beds of rock then laid down, known as the Hamilton, contain in places quite a percentage of magnesia and clay, and embody those vast deposits of hydraulic limestone which, in southern Indiana, have been so extensively used in making natural rock cement.

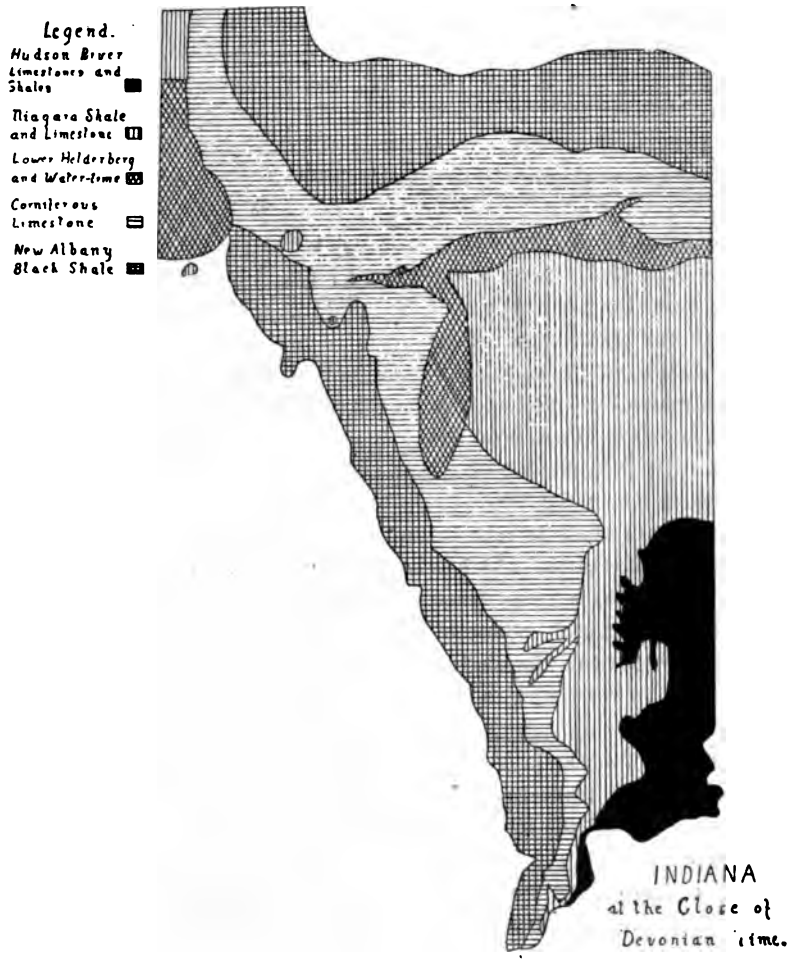
The Corniferous rock, when raised above the surface and added to the pre-existing land of the State, formed along the western margin of the latter an irregular strip 5 to 40 miles in width, extending from the present bed of the Ohio River at Jeffersonville northward to the present sites of Logansport and Monticello. North of the Wabash it has been found to be the surface rock in a number of the deep bores sunk for oil, but on account of the thick mantle of overlying drift, its exact limits are unknown. It is probable, however, that at the close of the Corniferous epoch a strip 20 miles or more in average width and extending nearly across the State was, in this region, raised above the floor of the old Devonian sea, to become a part of the permanent land of the future State.

During the latter part of the Devonian Era those lowly acrogenous plants known as Rhizocarps flourished in vast numbers in the fresh waters and brackish marshes of the time, and their spores by countless millions of tons were carried out as sediment into the surrounding seas. Mingling with the mud and silt and sand, brought down by erosion from the rapidly increasing land surface, they formed those vast mud flats which have since, by age and pressure, been consolidated into the thick beds of brown and black, finely-laminated shales which form the rocks of the Genesee epoch in Indiana. At New Albany the outcrops of this shale are 104 feet in thickness and especially prominent, so that the local name, "New Albany black shale," has been given it by geologists of the State. Along the western edge of the Corniferous limestone this shale forms a continuous strip, 3 to 35 miles in width, reaching from the present site of New Albany north and northwesterly to Delphi and Rensselaer. Over much of this strip it is covered by a thick mantle of drift, but everywhere within the area wells or the eroding streams have proven it to be the surface rock. The black shale has also, by deep bores, been found to be the rock immediately underlying the drift over much of the area embraced within the two northern tiers of counties in the State.

The Genesee shale is rich in bitûmens, derived from the spores of the ancient Rhizocarps, which also gave it color. When kindled, it will burn until they are consumed, and it is therefore, by the uninitiated, often mistaken for coal. These bitumens are, by natural processes, sometimes separated from the shale and in the form of gas or petroleum are collected in reservoirs in it or in the underlying Corniferous limestone.

During the thousands of centuries of the Devonian Period, a great advancement took place in the flora and fauna of the times, especially in the vegetation of the land and the development of the higher aquatic vertebrates. Among the acrogens growing on land, ground pines, tree ferns and equiseta or horse-tails came into existence and flourished in vast numbers. Their remains are often found in the Corniferous limestone, into the sediment of which they were drifted and preserved. The first Phanerogams, conifers of the yew and cycad families, were also evolved, their leaves and branches being found in the upper or Hamilton beds of the Corniferous epoch. As the land plants increased in number and variety, insect life became more varied and numerous.

Mayflies abounded and the first musicians of the earth appeared in the form of Orthopterans which, by means of their shrilling organs, enlivened the solitudes of the strange old Devonian forests with their love calls and wooing notes. Among fishes, the Ganoids and Selachians,



of which our gar-pikes, sturgeons and sharks are degenerate descendants, reached the acme of their development; while gigantic species of Dipnoans or lung-fishes, now only represented by the dog-fish or "John A. Grindle," abounded in the bays and bayous about the ancient Genesee flats.

At the beginning of the Lower or Sub-Carboniferous Era, which followed the Devonian in regular sequence, we find more than half of Indiana above the level of the sea. By the deposition and subsequent raising of the rocks of the Corniferous and Genesee epochs, the gap between the large area of Niagara limestone in the eastern part of the State and the mainland to the northwestward had been filled and that portion of the future Indiana became for the first time a part of the slowly growing North American continent. The rocks which were afterward added on its western side were deposited on the sloping floor of the Central Interior sea which stretched far away to the southwest, and they consequently have a notable dip in that direction.

The lowermost stratum of the Sub-Carboniferous rocks in Indiana is a thin but very persistent bed of greenish limestone, known as the Rockford Goniatite limestone. It is but about two feet in thickness at its most notable outcrops, and hence forms but a very narrow area of the surface rocks of the State. It serves well, however, as a line of demarcation separating the Upper Devonian shales from the thick beds of Knobstone which represent one of the early and important epochs of Lower Carboniferous time.

These Knobstone rocks consist at the base of a series of soft, bluish shales, which gradually become more arenaceous or sandy, until toward their western horizon they merge into massive beds of impure grayish sandstone. The formation ranges in known thickness from 440 to 650 feet. The name "Knobstone" was first given it by that eminent geologist, David Dale Owen, because its siliceous strata weather into those peculiar conical "knobs" or hills which are so prominent a feature of the topography in the southern unglaciated portion of its area. By the deposition and upraising of the Knobstone a strip of territory, 3 to 38 miles in width, extending from the Ohio River southwest of New Albany north and northwesterly to a point a few miles south of the present site of Rensselaer, Jasper County, was added to the existing land of the future State. Deep bores have also shown the Knobstone to immediately underlie the drift in a strip of varying width along the extreme northern border of the State. By its deposition and subsequent upraising over this area, all of the northeastern portion of the State became for the first time dry land, and the waters of the Eastern Interior Sea were forever banished from the future Indiana.

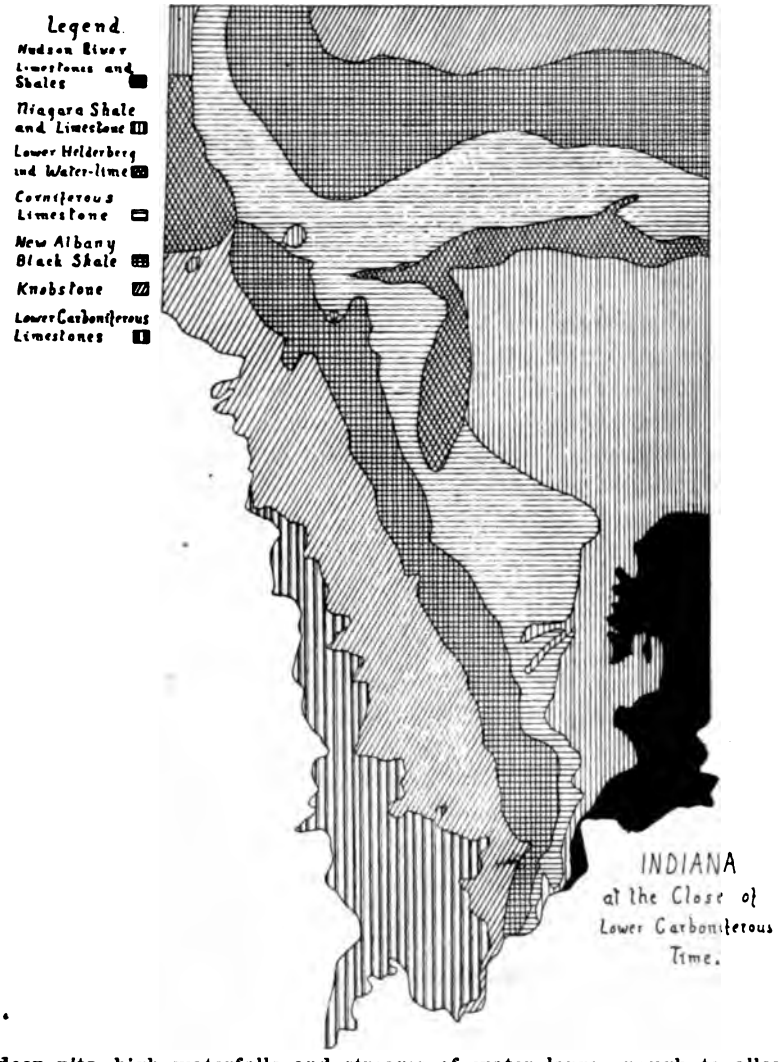
Over much of the northern part of its main area in Indiana, the Knobstone is at present more or less covered by glacial debris, its strata being exposed only in the stream valleys. The shales of the basal or eastern third of its unglaciated portion are excellently adapted to the making of vitrified wares, as paving brick, sewer pipe, etc., as well as for the clay ingredient of Portland cement; though as yet their possibilities of service for these products have been largely ignored.

Following the Knobstone epoch came that of the Lower Carboniferous limestones. Four distinct horizons of these limestones are recognized in Indiana, viz., the Harrodsburgh, Bedford, Mitchell and Huron, in the order named; each representing a distinct period of deposition in the slowly retreating Central Interior Sea. Their total thickness is nearly 600 feet, and together they form the surface rocks over an area 40 miles wide on the Ohio River, but which gradually narrows northward until it disappears beneath the drift in the vicinity of Crawfordsville, Montgomery County.

Of the four horizons that of the Bedford is by far the most noted, since from it is obtained that famous Bedford or Indiana oölitic limestone which is now widely recognized as the finest building stone on the continent of America. It is mainly composed of the globular shells of microscopic foraminifera or Rhizopods—minute one-celled animal organisms—which must have swarmed in untold myriads in the sea waters of the time. The shells or cell walls of these animals were composed of a very pure carbonate of lime, and when they died and sank on the old sea bottom these shells were cemented together by the same material. Under the lens they resemble a mass of fish eggs soldered together, hence the name "oölitic," meaning "like an egg." The Bedford stone is noted among architects for its strength and durability, and for the ease with which it may be sawed or carved into any desired form. For many years it has ranked as one of the principal natural resources of the State.

The "Mitchell limestone" overlying the oölitic is composed of a series of close-grained limestones, shales and cherts. Its outcrop—5 to 30 miles in width—is a fairly level plateau which is pitted with a great number of sink holes, many of which form the openings into underground caverns and the beds of subterranean streams. The thick beds of Mitchell limestone, taken in connection with the underlying Bedford and Harrodsburgh limestones, afford a series of rocks which are more

or less jointed, and therefore easily eroded by underground waters. As a result, large caves, some of them possessing great vaulted rooms,



deep pits, high waterfalls and streams of water large enough to allow the ready passage of a boat, are found throughout this area. All of these caves are due to the action of water—that greatest of nature's

solvents and abraders—its work of a day, a year, a century, upon the solid limestone not appreciable to the eye—yet by slow unceasing action through the ages which have elapsed since that limestone was raised above the sea, it has carved every room and passage, constructed every pillar and stalagmite existing beneath the surface of southern Indiana.

The Huron limestone or Huron group of rocks represents in Indiana the latest epoch of the Lower Carboniferous Era. It is composed of three beds of limestone with two intervening beds of sandstone, their combined thickness being about 150 feet. The sandstones carry in places concretions of iron ore and thin beds of coal, the latter being the forerunners or harbingers of those vast veins of stored energy which, in southern Indiana, represent the Carboniferous and final era of Paleozoic time.

The Carboniferous Era is noted as one of gentle oscillations in the surface of those shallow seas bordering the land, these "causing successive more or less wide emergencies and submergencies, the former favoring the growth of boundless forests and jungles, the latter burying the vegetable debris and other terrestrial accumulations beneath fresh water or marine deposits."

During the era, that cryptogamous land vegetation which had sprung into existence in the Devonian Era, advanced with wonderful strides. The temperature was mild; tne atmosphere moist and heavy laden with carbon dioxide. As a result the vast lowland marshes were overgrown with great trees of Sigillaria, Lepidodendron and Calamites; while at their base grew dense thickets of fern underbrush, inhabited only by insects and amphibians. For the first examples of the latter evolved during this period from some mud-loving, fish-like creature. No flowering plant had as yet unfolded its petals. No bird had, as yet, winged its way through the buoyant air. No mammal was, as yet, a denizen of earth or sea. Those dim watery woodlands were flowerless, fruitless, songless, voiceless, unless the occasional shrill of a cricket or grasshopper could be called a song. Yet in the cells of the semi-aquatic plants and trees of those old forests there was stored that heat which was destined in after ages to be freed by man and used in doing the work of the world.

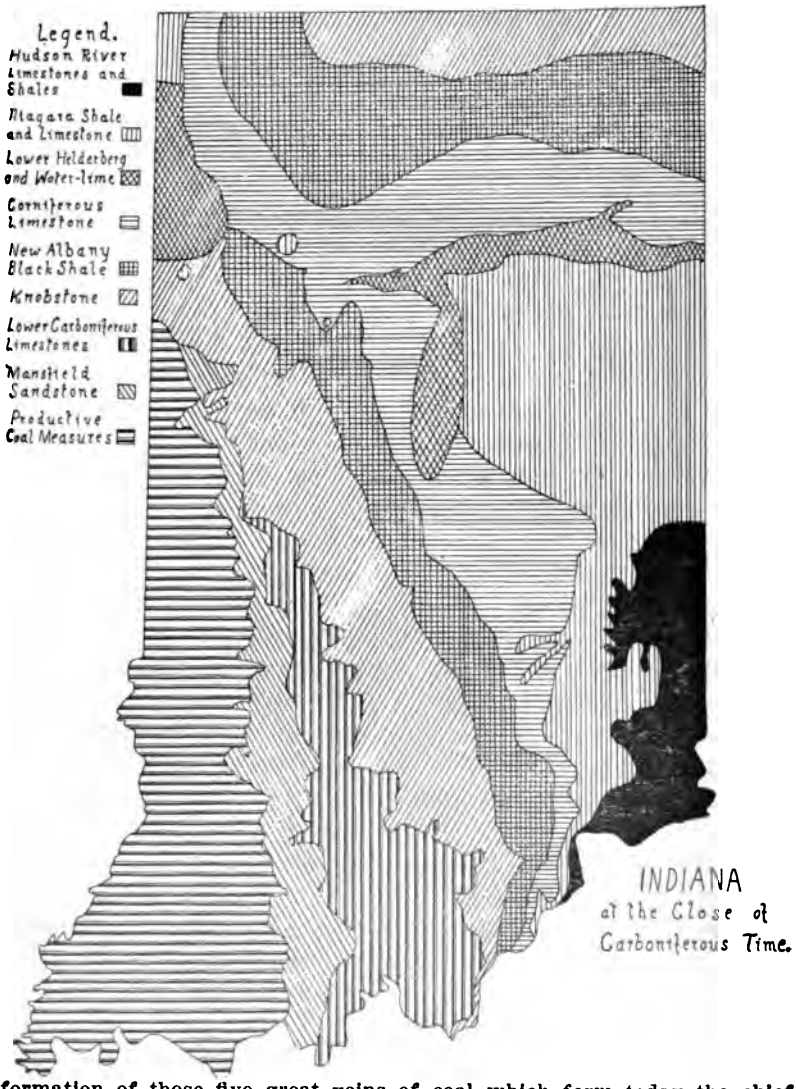
The rocks laid down during this era were alternating beds of sandstone, shale, clay and limestone with occasional beds of compressed vegetation which, during after centuries, has been changed into coal.

The basal formation of the Carboniferous Era in Indiana, as generally elsewhere, is a bed of coarse-grained sandstone, known as the Mansfield sandstone or "Millstone Grit." It has a total thickness of 150 feet and forms the surface rock over a strip 2 to 22 miles in width, extending from the northern part of Warren County in an east of south direction to the Ohio River, a distance of 175 miles. In Martin and Orange counties it occurs with an even, sharp grit, furnishing a most excellent material for whetstones and grindstones.

Above this sandstone are the Productive and Barren Coal Measures, which comprise 7,500 square miles of the land surface of the State. At the time of their deposition or formation the area which they cover, as well as a large part of Illinois, was a great basin or depression, but little above the level of the sea, and surrounded on every side except the southwestern by the higher lands of the older formations. By successive alternations of upheaval and subsidence—carried on through thousands of years—this depression was at times an area of the southwestern sea, again a fresh water lake, and then, for a period, a vast swamp or marsh. When raised high enough to form a marsh, the luxuriant vegetation, above mentioned, sprang up from the ooze and mud at its bottom, flourished for centuries, the newer growths springing from between the fallen masses of the older, as in the peat bogs of today, and so formed a mighty mass of carbonaceous material. By subsidence, the level of the marsh was, in time, lowered until it became a lake into which rivers from the surrounding highlands flowed, bearing with them millions of tons of clayey sediment and disintegrated quartz, the remains of the older decayed rocks. This sediment was spread out over the mass of submerged vegetation, compressing it into the hard, mineral coal; the clayey sediment itself being in time compressed into vast beds of shale, and the particles of quartz into sandstone. In some places a more prolonged subsidence took place, sinking the floor of the lake below the level of the sea, and allowing the waters of the latter with their accompanying forms of marine life to flow in. In time beds of limestone were then formed over those of the shale or sandstone, but none of these cover an extensive area or are of great thickness.

After each subsidence, with its resulting beds of coal, shale and sandstone or limestone, had taken place, an upheaval followed. The floor of sea or lake was again raised so near the surface that the semi-aquatic

vegetation for a new coal seam could spring up and, in time, the processes above detailed were again undergone. Such, in brief, was the origin and



formation of those five great veins of coal which form today the chief mineral wealth of our State, and of those vast beds of overlying shale which, in recent years, have come to be used for so many varied products.

We have now traced the growth of the area comprising Indiana through Paleozoic time. We have seen how that area gradually appeared above old ocean's rim. But it was not yet the "Indiana of Nature"—the finished product of the ages ready for the advent of man. Centuries untold had yet to come and go before it was complete—centuries during which changes of momentous importance were to come to pass. For, as yet, no palm, no angiosperm or flowering plant with seeds, no osseous or common fish, no reptile, no bird, no mammal had come to be upon the surface of the earth. All these were evolved from pre-existing forms during the age or era immediately succeeding the Carboniferous or final period of Paleozoic time. This age is known as that of the Mesozoic or Middle Time, represented by the Triassic, Jurassic and Cretaceous eras. For our purpose there may be combined with these eras the Tertiary of Cenozoic or recent time. During the myriads of years ascribed to these eras, while vast changes were taking place in other parts of the American Continent, the surface of Indiana probably remained above sea level. On it there grew the plants and over it there doubtless roamed, in their turn, the animals of each successive era, but as its surface was above the sea, they left no fossil bone or footprint to tell us of their presence.

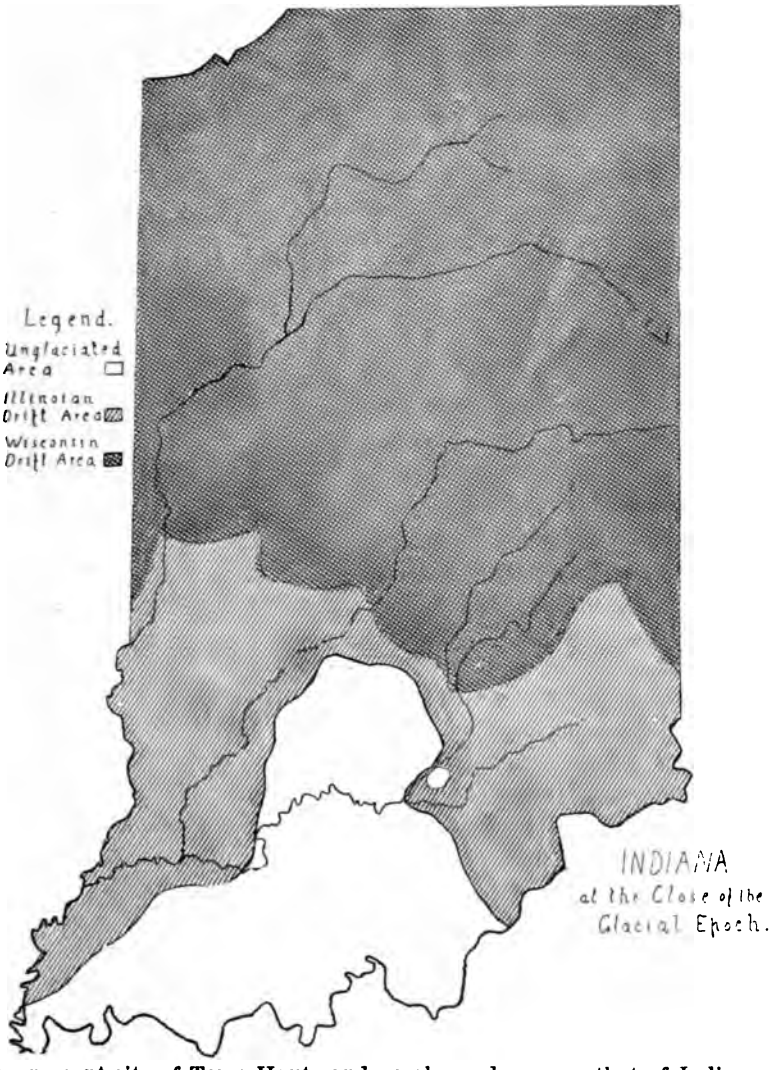
All this time, however, the silent processes of nature were unceasing in their labor, and wrought great changes in the surface of the future State. Decay and erosion were in action then as they are today. Sunshine and rain, wind and frost, trickling rills and strong streams were ever at work, softening and sculpturing and wearing down the exposed rocks, forming clays and sand and gravel and bearing them away to lower levels. At the close of the Tertiary Era, the entire surface of what is now Indiana resembled that of today in the driftless area of its southern part, being cut up by erosion into a complex network of valleys, ridges and isolated hills. In certain portions of the northern half great streams, of which there are now no surface indications, had worn their channels a half mile in width, 200 feet or more down into the solid Niagara limestone. The Ohio River valley, a trench from one to six miles wide and 400 feet deep, was mainly eroded during this period, as was also the greater portion of the Wabash Valley, from Huntington to its mouth. Everywhere over the surface was a thin soil, formed from decaying rocks and vegetation, poorer, perhaps, than much of that which at present covers the surface of the driftless area, where the underlying limestones and shales have been the parent rock. In this soil grew the cedar and the

sassafras, the willow and the maple, the oak and the beech, while over its surface spread many of the coarser grasses, sedges and mosses of the present day.

During these long periods of erosion and decay, mild climatic conditions had prevailed. But near the close of the Tertiary a change in these conditions came gradually to pass—a change which was most sweeping and far-reaching in its final results. For some, as yet unknown, reason, the mean annual temperature of the northern hemisphere became much lower. The climate of the regions to the east and south of Hudson's Bay became similar to that of Greenland of today, or even colder. The snow, ever falling, never melting, accumulated during hundreds of centuries in one vast field of enormous thickness. Near the bottom of this mass a plastic, porous sort of ice was gradually formed from the snow by the pressure from above. This ice mass or glacier took upon itself a slow, almost imperceptible motion to the south or southwestward, until it covered three-fourths or more of what is now Indiana. As it moved slowly southward great masses of partly-decayed rock and clay from hillsides and jutting cliffs rolled down upon it and were carried on and on until, by the melting of their icy steed, they were dropped hundreds of miles from the parent ledge. Large irregular masses of rock from the region in which the glacier was formed were either frozen into its nether portion or rolled along beneath it, and as the ice sheet moved they served as great stone drags, grinding down and smoothing off the hills and ridges and filling up the valleys, until the irregular, uneven surface of the old preglacial rocks was planed and polished.

From the striæ formed by these imprisoned boulders and from other evidence which it is difficult to otherwise explain, it is now believed that there were several distinct epochs in the glacial period. The great ice sheet, which was at first formed, several times advanced and as often—by an increase of the temperature of the region which it entered—melted and receded; its retreat or recession being each time as gradual as its advance had been. Like a great army which has attempted the invasion of a country and has been compelled to withdraw, it would again assemble its forces and start in a slightly different direction. But, perchance, before it had reached the limit of its former invasion a force of circumstances would render a retreat necessary. Its advancing margin was thus not in a straight line, but in lobes, or long, gradual curves.

When the first ice sheet reached its greatest advance into the region now comprising Indiana, the ice "was at least 500 or 600 feet deep over



the present site of Terre Haute and nearly as deep over that of Indianapolis, and it thickened gradually northward. If an observer could have stood on one of the hills in Brown county at that time, he would have

seen to the east of him the great wall of the ice front extending south toward Kentucky, while toward the west it would have been seen in the distance stretching away toward the southwest. For hundreds of miles to the east and west, and for 2,000 miles or more to the north, the glaring, white desert of snow-covered ice, like that seen in the interior of Greenland by Nansen and Peary, would have appeared, stretching away out of sight, with not a thing under the sun to relieve its cold monotony."

By the incursions of the various ice sheets all the so-called "drift soils" of northern and central Indiana were accumulated where they lie. Derived, as they were, in part, from the various primary and igneous rocks in the far north, ground fine and thoroughly mixed as they were by the onward moving force of a mighty glacier, they are unusually rich in all the necessary constituents of plant food. Principally to them does Indiana owe her present high rank as an agricultural state. All the level and more fertile counties lie within this drift covered area, and its southern limit marks, practically, the boundary of the great corn and wheat producing portion of the State. But few of the present inhabitants of Indiana realize how much they owe to this glacial invasion of our domain in the misty past. It not only determined the character of the soil, the contour of the country and the minor lines of drainage, but in manifold other ways had to do with the pleasure, the health and the prosperity of the present population.

When the final ice sheet gradually receded from the area now comprising Indiana, the surface of the glaciated portion was left covered with a sheet of drift or till composed mainly of clay, gravel and boulders, and varying in thickness from one to 400 feet or more. Over the greater portion of this area the surface of the drift was comparatively level, but in the northern fourth of the State it was in numerous places heaped up in extensive ridges and hills, due to irregular dumping along the margins and between the lobes of the melting ice sheets. In the hollows or low places between those ridges and hills the waters of the melting ice accumulated and formed those hundreds of fresh water lakes which are today the most beautiful and expressive features of the landscape in the region wherein they abound. At first all of those yet in existence were much larger than now, while for every one remaining a score have become extinct.

A new vegetation soon sprang up over the land left desolate and barren by the retreating ice. The climate gradually became much

warmer than it is today. The great expanse of water in lakes and rivers, aided by the increase in temperature, gave rise to excessive moisture. Fostered by the rich soil and the mild, moist atmosphere, a vast forest of deciduous trees spread over the larger portion of our State. Through this forest and about the margins of the lakes and marshes there wandered for centuries the mammoth and the mastodon, the giant bison and the elk, the tapir and the peccary, the mighty sloth and that king of rodents, *Castoroides ohioensis*. Preying upon these and smaller mammals were the great American lion, and tigers and wolves of mammoth size. The bones and teeth of all of these species of extinct animals have been found buried beneath the surfaces of former bogs and marshes in various portions of the State. It is not improbable that with them was also that higher mammal—man—in all the nakedness of his primitive existence.

But over this phase in the evolution of the future Indiana there came again a change, for nature knows no such thing as rest. The great rivers which had borne south and southwestwardly the floods and debris of the melting glaciers gradually diminished in size and filled but a small portion of their former valleys. Extensive shallow lakes in the northwestern part of our present area gave way to marshes and these, in time, to wet prairies, possessing a rich black soil derived largely from the decay of aquatic vegetation. The climate gradually grew less moist, more cool. The mammoth, the mastodon and contemporaneous mammals disappeared, and in their stead came countless thousands of buffalo and deer. With them came, too, that son of Nature—that descendant of the naked barbarians of centuries before—the noble Red Man. From out of that dark night which hangs forever over all we know or shall know of early America he came—a waif flung by the surge of time to these later ages of our own.

With the advent of the Red Man the "Indiana of Nature" was complete, was perfect. It possessed that primeval savage beauty of a world unmarred by man. Lakes, streams, forests, prairies, stored fuel, noble game—all were here. For centuries the Indian lived in peace within its bounds. The forest yielded him bear and deer—the prairies, buffalo and wild fowl. On the higher ridges, overlooking the larger streams and lakes, he had his principal village sites. Over their placid waters he paddled his birch bark canoe. From their depths he secured with spear and hook fishes sufficient to supply his needs; while the skins of muskrat, otter and beaver which he trapped about their marshy margins

furnished him protection against the cold. Through the forest glades, when returning from the chase, his cries of triumph were echoed. Here, in a land of plenty, his wants were few and easily satisfied; his ambitions lowly, his hopes eternal.

But to this, as to all things peaceful, there was an end. From across the seas came that "prince of parasites," the white man—self-styled heir to all the ages—so-called conqueror and civilizer—but in reality the greatest devastator that Nature has ever known. First as a discoverer came he. Then as a trapper and trader among the Indians; last as a settler of the future State. His first permanent hamlets or settlements were, like those of the Indians, located on the larger streams. From these he penetrated farther and farther the forest, building his cabins wherever a spring purled forth from a hillside to furnish water. In less than two centuries—a mere second as compared with those measureless eternities before he came—the white man has changed beyond recognition the "Indiana of Nature." Only its outlines remain as they were.

From its bounds he has driven forever the buffalo, bear, panther, elk, deer, wild turkey, ivory-billed woodpecker, paroquet and wild pigeon, together with the noble Red Man, the one-time contemporary and lord of them all. From its surface he has cleared that dense forest of tall trees—of which no domain could boast a better—leaving in its stead a mere remnant of what would have been termed underbrush a century ago. Following the felling of the forests came, as a direct result, the drying up of springs and the dwindling to mere rivulets of former creeks and streams. To gain control over a few more acres of mother earth, he has dredged deep ditches and so lessened greatly the size or brought about the total extinction of 90 per cent. of those crystal lakes which once gave variety and beauty to the northern fourth of the State.

He has caused the picturesque trails and woodland paths of the Indian to disappear, and in their stead we find, at intervals of a mile or two, those broad unshaded roadways, many of which are floods of dust in summer and seas of mud in winter. As a complement to these he has, in nearly every county, leveled hills, filled up valleys, bridged streams, and stretched long bands of steel spiked to wooden ties. Drawn by the harnessed forces of Nature, he rushes over these at almost lightning speed; while along them he sends, with many a roar and rumble, those necessities and luxuries of his artificial life.

Not content with his destruction of the natural beauty of the surface of the State, he has delved deep into its depths, in search of those riches of stored power, there hidden since the sun gave up its heat and light to the plant cells of the old Silurian seas and Carboniferous marshes. With his iron drill he sunk, in eighteen years, ten thousand vents to the Trenton rock. Through these there poured natural gas valued, even at the extremely low price at which it was sold, at $77,618,189. So greedy was he, so ignorant of the real value of this gaseous fuel and the manner of its formation, so reckless in its consumption, that at the end of less than a score of years there remains only the dregs of the plenty that has been.

As with natural gas, so with its mother liquid, crude petroleum. Since 1891, 16,975 bores have been sunk within the limits of the State, for it alone. Through these 55,172,755 barrels of oil, valued at $42,757,-834, have reached the surface. But few years will elapse before the stored supply of it, too, will have vanished. A priceless gift of nature—hundreds of millions of years in forming—it will be sacrificed to the greed of the white man in less than the life of a generation of his kind.

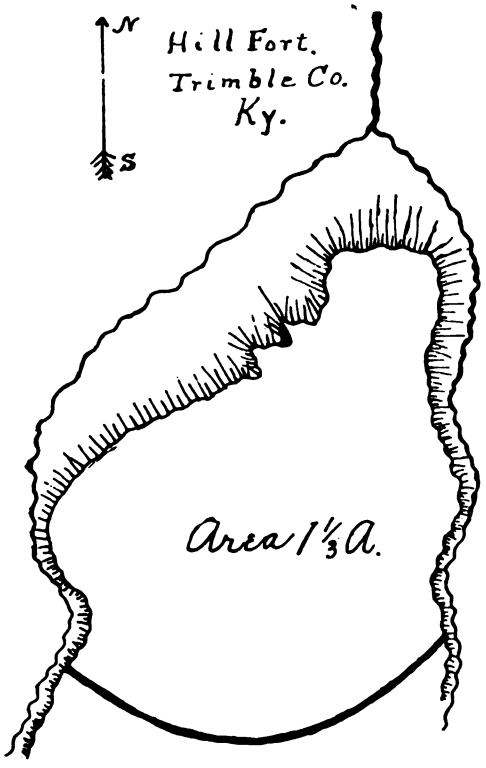
More valuable than either gas or oil, closer to the surface and, therefore, more easily secured, are those vast veins of coal which underlie the southwestern area of our State. For sixty years man has sunk his shafts and pitholes to their levels, and tunneled miles along their courses, until the output has risen above nine million tons per annum. Less than two centuries will see the end of this stored fuel, and Indiana will then have been raped of all those riches which, in the ages past, were formed beneath her surface.

But why continue? Examples manifold could yet be given of the changes wrought by man since first he gave the name Indiana to the area in which we dwell—changes which one and all have but marred the face of nature and left everywhere the signs of his greed, his egoism. Only the great blue ethereal dome—the sun which shines and rules over all—the moon, cold and lifeless—the stars, gleaming from their heights in the realms of space—the clouds which oftentimes hide even these from view—seem as they were when the Indiana of Nature was first perfected.

A Prehistoric Fortification Near Madison, Indiana.

By Glenn Culbertson.

On the farm of Mrs. James Snyder in Trimble county, Ky., and at the head of Broadway Hollow, so-called because it is directly across the Ohio river from Broadway in Madison, Ind., is located a prehistoric fortification. To a few people in the immediate vicintiy this fortification is



known as the Indian fort, but to my knowledge it has never been described, although it is one of the most interesting remains of prehistoric people in all that region.

The hills in the vicinity of Madison are approximately four hundred feet above low water level of the Ohio river. They are capped by the

resistant Niagara and Clinton limestones, underlaid by the soft Hudson shales. Hence bluffs and precipitous slopes are not at all infrequent. The fortification, mentioned, is situated about a half mile back from the bluffs and steep slopes facing the Ohio, and between the two principal tributaries of the stream which occupies Broadway Hollow. These streams have eroded deep but narrow valleys which in the upper portions are enclosed in part by perpendicular cliffs.

The fortification, as may be seen from the map, is roughly triangular in shape and is bounded by cliffs some 75 feet high near the apex at the north end. These cliffs become lower gradually as the south side of the fortification is approached. At the southwest angle the height is still some thirty feet, while at the southeast angle the height of the cliff is at present not more than eight or ten feet.

The neck of land beeween the two streams at the south was fortified by means of a stone and earth wall, with a ditch or moat on the outside. The remains of the wall, except on the steeper slopes near the ends, form a mass of earth and stones some ten feet wide at base and three or four feet high. The ditch outside is still six or eight feet wide and has a maximum depth of two or three feet below the original surface. The wall was about one hundred and twenty yards long and strongly curved outwards. The area of the fortification proper is about one and one-third acres, and as the site of the fort has never been cleared of its forest growth, it is still covered with thick underbrush and small trees.

The fortification is admirably located for the purpose of defense. On two sides of the triangle it would be almost impossible for an enemy to enter the fort even if undefended, except, perhaps, at the southeast angle, where in all probability a supplementary wall was built. The stone and earth wall across the neck may have been, and probably was, surmounted by a stockade, as was done in case of many of the prehistoric fortifications in Ohio. There are, at present, however, no evidences of a stockade visible.

Of the different kinds of prehistoric fortifications now known and recognized, viz., signal and observatory stations, stockade forts, hill forts and stone forts, this one should probably be classified as a hill fort, and was intended as a place of retreat on the approach of an enemy. The tribe or clan using the fort probably cultivated the fertile bottom lands near, and fled to the fort as occasion demanded. This fortification may have

been used as an observatory and signal station, also, but was not one of a series known to extend along either side of the Ohio River, since from this point it is impossible to see or be seen from the Ohio at any distance either up or down. The site is an admirable one, however, for signaling across to the headwaters of Indian Kentucky creek, in Indiana, along which are found many evidences of prehistoric inhabitants. There are no visible ash or charcoal remains in the vicinity of the fort, so the signal theory remains unproven.

A Note on the Breeding Habits of the Common or White Sucker.

By Glenn Culbertson.

While fishing on Big Creek in Jefferson County, Ind., last April the writer had an opportunity to observe at short range the spawning habits of the common White Sucker (Catostomus teres). It is the habit of this fish to spawn in the swiftly flowing water of ripples rather than in the still water of pools, and if I am not mistaken during the night rather than the day.

In the case under observation there was a school of suckers, some twenty or twenty-five in number, and ranging in size from nine or ten inches to thirteen or fourteen inches in length. The location was a short reach of swift water some three or four inches in depth, between two large pools. The ripple was close to a steep bank and was overhung by the branches of trees, making the place rather dark even at noon. The fish with few exceptions were constantly swimming about, now in the deeper water and, again for a short time in the shallow water of the ripples. A few were lying quietly on the bottom in the swift water.

My attention on observing the school for a few minutes was soon attracted to a large female, thirteen or fourteen inches in length and two males about ten or eleven inches long. Whenever this particular female swam from the pool above down into the swift water, the two males, which always swam approximately side by side, and some five or six inches apart, would endeavor to pass one on either side of the female. In the one case where the actual spawning occurred, the two males reached positions close to and on either side of the female and with the anterior portions of their heads some two inches farther back than that of the female, the heads of all being upstream. While thus stationary in this position the males struck the female each with head and then tail, alternately, and with great rapidity. This motion was continued some four or five seconds. At the same time, the swift water of the ripple below the spawning fish became of a milky white color, due to the spermatic fluid of the males. On taking the same female a few minutes later the

spawn was found to be abundant and to pass very readily from the body. On taking two or three of the males the usually smooth portion of the heads was found to be covered with numerous tubercles from one to two millimeters long. The tail fins of the males were also found with rows of similar tubercles along the rays. No tubercles were found on the female.

The spawn could have done nothing else than to have floated off into the still water of the pool below, where some may have found lodgment among the water plants.

Whether polyandry, or perhaps more exactly diandry, if the term may be so used, is always the habit of the female sucker I am unable to say, but in this case it certainly was.

Notes on the Caves of Cuba.

By J. W. Beede.
(By title.)

Effect of Ultraviolet Light on the Action of the Coherer.

By Arthur L. Foley.
(By title.)

The Life of Radium.

By Arthur L. Foley.
(By title.)

"Colds" and Cold.

By Robert Hessler.

It is often said that on account of variable weather conditions, that is, sudden and violent atmospheric changes, the climate of Indiana is an unhealthy one and that this is the reason why "colds" are so common among us. Now is this true, especially the deduction?

Most of us, I believe, will admit that changes in temperature are rather sudden at times and that the daily weather conditions are quite variable, but that our climate—that is, the sum total of all weather conditions for long periods of time—is one conducive to the production of "colds," per se, may be denied by some.

Now when I speak of a "cold" I am assuming that everybody knows what that means. A cold—why, yes, of course. Everybody knows what a cold is.

As a matter of fact many think they know—which is something entirely different. We all know the dictionary definition: "Cold.—An indisposition commonly ascribed to exposure to cold; especially, a catarrhal inflammation of the mucous membrane of the nose, pharynx, larynx, trachea, bronchi, or bronchal tubes." (Century.)

Physicians use the term very freely in conversation or consultation with their patients. There is good reason for this. When the patient comes to the physician he not only wants a medicine or a prescription but he also wants to know about his disease or affection; he will want to know the name at least, and very likely also the cause. We all want an explanation of what is wrong when we are sick, and the simpler the explanation the better. If the physician wants to be exact and gives the explanation in technical terms that have a definite meaning, then he must explain the terms themselves, all of which takes a lot of time—and so the busy practitioner has recourse to a number of terms and phrases which have long been in use and with which the laity are familiar. When, therefore, the anxious patient asks for the common name of his disease or for its cause, and the knowing physician answers assuringly and perhaps authoritatively the magic word "cold," all is serene. Such words as

cold, rheumatism, malaria and the like are timesavers. Such terms are often used both in the sense of cause and effect.

Well, I don't see where I got my cold or caught my cold, the patient will say. Well, I don't either, the physician may reply, while he writes the prescription or puts up the bottle of medicine. In the meantime the patient will mentally go over the events of the past few days until he finds where, as he thinks, he has exposed himself to cold, perhaps to a draught or went out bareheaded; and then he is able to account for his illness or for his "cold." This is all very simple.

Now, as a matter of fact the term cold as ordinarily understood as an ailment, or even as a cause for an ailment, has practically gone out of use among physicians themselves, and the word is seldom seen in the best medical literature of today.

But let us return to the popular use of the term. Colds in the human body have a most varied form of manifestation. A cold in the head is perhaps the most common. We often hear of colds settling in certain parts of the body or of traveling about from one organ to another. A cold which begins in the nose may travel down into the lungs or down the alimentary tract. Affections with different names may follow, such as catarrh, or tonsilitis, bronchitis or pneumonia, or congestion of the stomach or liver or kidneys; we also hear of colds in the eyes and ears.

Now a "cold" in the sense of a bodily ailment is by many of us intimately connected with cold in the physical sense, that is, the absence of heat or a lessened amount of heat in the atmosphere. An ingenious explanation that I once heard was this: A sudden alternation of heat and cold acts on the mucous membrane as it does on glass—it causes it to crack, and then disease results. This would be a simple explanation why Indiana, with its great and sudden variations in temperature, is unhealthy.

Now, this sounds plausible, and yet we are told by arctic explorers that they are singularly free from colds—and acute respiratory affections generally—while in the far north, notwithstanding that they go from their warm huts or cabins out into the intense arctic cold, where the contrast is much greater than any changes in Indiana. It would seem that if a cracking of mucous membranes takes place at all it would certainly take place there, and disease result.

It is a common observation that colds are most prevalent among us during the cold season, and so we naturally associate cold with "colds,"

yet explorers tell us that "colds" are practically unknown in the far north —there must need be some other explanation.

Our domestic animals with an anatomy and physiology closely resembling our own are not subject, at least to any extent, to diseases of the respiratory tract or to colds.

If our State is unhealthy, I believe we must look elsewhere than to the climate to account for the prevalence of respiratory diseases, and especially colds. The old pioneers and the farmers at the present time living in thinly-settled districts do not complain of the climate; they have been and are healthy.

The use of natural gas and overheated rooms is a fruitful cause of colds, we are told. Fires burn day and night and dry out the atmosphere, and this causes the respiratory mucous membranes to become dry and inflamed. This sounds reasonable, but, we may ask, why do not the inhabitants of dry, arid plains or deserts—with an exceedingly hot and dry atmosphere, exceeding that of our rooms—why do they not suffer from inflammations and colds? The Bedouins are said to have such delicate or sensitive mucous membranes that they can not bear the odor of a city; however, at times of windstorms they get nose and throat full of sand and dust and yet they are none the worse the day after.

Physicists tell us that the amount of moisture the air is capable of holding depends on its temperature; the higher the temperature the more moisture it can hold. A very cold air may be a very dry air which may take up considerable moisture on coming in contact with the respiratory membranes—yet it is known that in an otherwise pure atmosphere no harm results. On the other hand, a hot, dry desert atmosphere may take up considerable moisture from these membranes, and this is readily supplied as long as the body contains sufficient fluid or where there is no excessive thirst. We see practically the same conditions in an iron foundry or rolling mill. In this excessively hot atmosphere the respiratory membranes of the men may suffer very little because they give off the fluid so freely supplied the body as drink. Membranes keep themselves moist in a dry atmosphere just as the skin keeps itself moist. As a matter of fact, the amount of moisture or the dryness of the air has nothing to do with the production of colds—other things being equal.

A variation of this hot-air and dry-room theory is that it is necessary to come in contact with the outer raw air before inflammation results; that this first brings on a congestion and this in turn is followed by the

inflammation or the cold. We may also be told that improper clothing plays an important part; that we either bundle up too much or that we do not dress warmly enough. Some persons account for their colds by the underwear used, both as regards material and texture.

Now, it is well known that individuals who in town are subject to colds will be free from them on going to the wild woods. The experience of hunters far away from civilization is of interest in this connection; they will undergo all sorts of hardships and exposures, get wet and cold, leave their little cabin with its red hot stove and step out into the cold winter air and back again, and yet they do not take cold.

Taking it all in all, it would seem that we will have to look elsewhere than to exposure to physical cold for the production of the affection we know as a "cold." It is not to be denied that we do take colds after an exposure, as we all know from experience, but there must be some other factor involved. Indeed, long ago that patient scientist and philosopher, Benjamin Franklin, arrived at this conclusion. In his autobiography are recorded a number of observations that he made on colds, and he came to the conclusion that simple exposure to cold was not a sufficient cause. What this something, this unknown factor, is he did not know—in fact we are just beginning to find out. I am almost inclined to believe that if Ben Franklin had been a physician or had had the education of a physician we would have known long ago.

Now, we have been using the term "a cold" without any real definition of its meeting; we assumed that everybody knows what a cold is, but as a matter of fact there is a whole list of words used by the laity in a loose way which all stand for the same thing. A cough or a running nose, headache, sore throat, catarrhal affections, tonsilitis, stiff neck, pleurisy, rheumatism, neuralgia, lumbago, gout, fever, malaria, inflammation or soreness of the kidneys and so forth, are either synonyms for a cold or are said to be due to cold or that a cold has settled in some particular part of the body.

For instance, the significance or meaning of the term malaria as ordinarily used may at first sight seem obscure, but it is very frequently used in those cases of "cold" where there is considerable fever and perhaps some chills. As a matter of fact, real malarial fever is a comparatively rare disease and is practically absent during the winter months. It can be definitely diagnosed by an examination of the blood, and cases usually require active medication, that is, the use of some antiperiodic like

quinine, before recovery takes place. Self-diagnosed cases of "malaria," that is "colds," usually get well in a short time, and without the use of large doses of quinine.

Popular medical terms are used in a very loose way and physicians using them among each other are constantly compelled to define them or explain just what is meant—and we all know of the proverbial doctors' quarrel.

Now, if a physician speaking before a medical society or in writing for a first-class medical journal used the term "a cold" and had to give a definition he likely would find it a difficult task. Perhaps on examining the underlying facts we may arrive at some definite conclusions and perhaps be able to make a definition. It would likely be something after this fashion: A cold is the reaction of the body toward some irritant or infective matter, the amount of reaction depending on the amount of this matter and its localization in the body; the reaction may be general or local; it differs from the specific fevers by its history.

During a cold some irritant substance is in the body. This irritant may differ in different forms of cold. The inhalation of certain gases or chemicals or vegetable substances may be followed by a transient cold. Some forms are regarded as due to the inhalation of pollen, as rose cold and hay fever; other forms occur in diseases like measles, scarlet fever and the like. A common cold differs from these special forms by its history.

As to causes: "Getting chilled" or "overheated," or "getting the feet wet" are not real causes of common colds—they are regarded as simply exciting causes or of opening up the avenues for the real cause. They stand in about the same relation as the plowing of the field does to the sowing of the seed--you can plow and harrow and prepare the ground as much as you please, but no crop will follow unless you seed the prepared ground. A "cold" will not follow an exposure to cold in the physical sense unless the seeds are present—and this is why arctic explorers are free from colds. Moreover, we know from experience that we can catch a cold in the hot summer days as well as in the winter time.

This brings up the question: Where do we get the seed of a cold? As elsewhere, we get the seed from a previous crop. We get our colds from persons who have colds especially that aggravating form of cold known as catarrh.

How is it transmitted? may next be asked. Through the agency of the dust we inhale, is the answer.

A short time ago we spoke of infective matter; this infective matter is the seed, placed in the dust by persons who have colds.

Now, this is all theory, some will exclaim. Let us admit it is a theory. Now, a theory is of value if it explains phenomena and in proportion as it explains it becomes a true theory; moreover, a working theory has value in enabling us to predict.

Let me cite a few instances or examples and see how this infective dust theory, if you choose to call it so, works out.

Men who in towns are constantly afflicted with colds and catarrhs, with pains and aches in the joints, and with headaches, are often singularly free from these complaints while in the country for an extended period. It is true that mode of life has something to do with this; the exercise, the plain food, etc., all contribute to their well-being, but one factor stands out above all others—the pure atmosphere with the absence of infective dust.

It has long been noticed by those susceptible to colds that a cold often follows a ride on the railway, and it is usually ascribed to some draught—to some open window or door. In reality it is due to the highly contaminated air of the car—the aisles at times resemble in filthiness the habitation of some domestic animal.

Since interurban cars have come into use a new phase of this question of railway colds, so to speak, has developed. The open car furnishes an abundance of fresh air while the closed one in the winter season may not differ greatly from the steam road cars in regard to the polluted atmosphere. Susceptible persons have often been puzzled how they catch cold on a closed car on a comparatively warm day and do not catch cold in an open car on a cold, raw day, say in the fall before the open cars are taken off. The one is all draught and the other has practically no draught. The discerning individual will readily see that the air of one is pure, while that of the other is not.

Individual susceptibility of course varies greatly. Some persons seem almost immune, or succumb only after an unusual exposure; the attack itself may be slight or severe.

Some men habitually employed in situations with infected dust seem almost immune. Railroad passenger conductors are usually the picture of health. This is easily explained: it is simply the action of the law of

the survival of the fittest. The managers of our railways are careful whom they employ and still more careful whom they advance. A conductor reaches his position by successive advancements, or the man best suited to the position gets the place. A consumptive conductor or one with a red, inflamed nose or watery eyes, or subject to chronic hoarseness, is almost an anomaly on our large railways—if such a man did not resign of his own accord because of his inability to adapt himself to the conditions, it certainly would not take long until the management "fired" him.

This weeding out process plays a most important part throughout life. The most susceptible perish early; long lived individuals are found mainly in thinly settled regions. It is often said of the backwood mountaineers of some of our Southern States that they do not die; they simply wither up of old age.

It is not to be understood that everybody is susceptible to dust infections; as in all other diseases, there are always some persons who escape, or who are attacked so slightly at the time of the prevalence of an epidemic that we can scarcely consider them affected. On the other hand, some individuals complain severely after each exposure, after a railway journey, or after the prevalence of a windstorm or after attending a crowded hall with poor ventilation, in fact any place where the atmosphere is contaminated. The cold may show itself the same day or not for several weeks, as in the case of pleurisy. With many persons about who are infected, the chance of becoming infected is of course greater.

The habit of sweeping and dusting a closed room while persons are compelled to be in it is a most reprehensible one—the dust stirred into the air irritates the respiratory mucous membranes, to say the least, and the feather duster is a fruitful source of coughs and colds; it is too often brought into action to dust the seats and furniture in a room or hall just prior to the arrival of an audience.* The accumulated dust of a week or more may be suspended in the air ready for inhalation, and we think little about it, although a thick layer of dust on a chair we are about to occupy strongly attracts our attention, and yet it is infinitely worse to inhale the dust than it is to get it on our clothing. It is evident that this stirred up

*NOTE.—To my certain knowledge this very thing occurred in the room where the Academy met; dust which lay thickly on the chairs was stirred up with a feather duster half an hour before we met. The amount of coughing and sneezing at the time this paper was read was so noticeable that the newspapers called attention to it.

dust is redeposited on our respiratory mucous membranes and only too often with evil results.

I have had many persons under observation who are subject to this dust infection, and where the source of their cold could be readily traced, and who, moreover, suffered less after it was explained to them how they catch cold—and in proportion as they have been able to avoid the inhalation of an infected dust atmosphere they have found the climate of Indiana a healthy one.

City and town people are, of course, the worst sufferers, and a sedentary life with a body habitually overloaded with food and waste products is a contributing factor—such a life places the body at a disadvantage in warding off or in resisting disease. Colds, moreover, often allow the entrance and spread of other diseases. We can frequently trace a dangerous disease back to the time of a "cold."

The subject is a serious one. According to the recent report of the Indiana State Board of Health last year, a total of 7,607 persons found their death breathing dust-laden air. Indeed, if the whole truth were known the total number would be even greater. The number of persons who are simply affected, made sick, and who do not die from the attacks of cold and diseases traceable to colds, is an extremely large one.

The experience of arctic explorers in the far north has already been referred to. Although severely exposed to cold, they are free from colds, and now it should be added that the moment they return to civilization they suffer most acutely.

We might be tempted to ask: Are "colds" a product of civilization? It would seem so. Civilized countries, however, differ greatly in the prevalence of colds and catarrhs and a host of infections due to infected dust—a number of which have already been mentioned. The inhabitants of many European countries suffer but little; inhabitants of the United States suffer greatly, and in our State colds and catarrhs are almost universal. I believe it was Charles Dickens who remarked about the accurate aim of the American in spitting, and travelers from the old world are amazed at the condition of our sidewalks and floors of public halls and railway coaches.

How far do we have to go to find the cause for the so-called unhealthy condition of Indiana It would seem that if our State is unhealthy, man himself has made it so.

I might stop here, but I am inclined to think that some one will say that the term "infective dust" is rather vague. A pathologist or bacteriologist would demand something more definite. He will likely call our attention to the little bits of yellowish or greenish matter which we so frequently spit up and which is coughed up in large quantities by persons severely afflicted with inflammation of the respiratory tract. He will tell us that this matter is made up mainly of white cells from the blood which have been killed off in the struggle with this so-called infective matter, and he will mention a lot of big names that are Greek to 999 in every 1,000 persons.

Now, I have purposely refrained from making use of the term microbe. A wise sanitarian has said that as long as you speak of infective matter you come in for very little criticism, but the moment you mention microbes the newspapers jump on you and ridicule the idea that dust is dangerous or that it is dangerous to spit whenever and wherever we choose. The newspapers are great factors in disseminating useful knowledge, and if they will not speak ill of infected dust but will antagonize any statements based on microbes, it seems to me that we would best stop and let the bacteriologist continue the discussion.

A Method of Determining the Absolute Dilation of Mercury.

By Arthur L. Foley.

(By title.)

What Bacteriology Has Done for Sanitary Science.

By Severance Burrage.

Sanitation, the science of disease prevention, has been practiced variously and in varying degrees from time immemorial; but it was of little importance and remained in comparative obscurity and impotence until the birth of bacteriology in the latter part of the nineteenth century. The establishment of this new science by Robert Koch in 1881 marked a most important epoch in the history and practice of preventive medicine. Sanitation at once became transformed from a puny, uncertain, "hit or miss" science into one of the most important factors in modern civilization. The causes of many diseases being positively known, the possible causes of many others being inferred, the sanitarian had the most important key in his possession for the prevention of those diseases. In other words, he became much better fitted to practice his profession. Furthermore, each separate branch of sanitary science has received from the bacteriologist definite knowledge which has made it far more exact and practical, and correspondingly more efficient.

Take for example the subject of disinfection. This science in various forms has been practiced for many centuries. Ovid states with regard to it, that sulphur was used by the shepherd of his time for purifying wool from contagious diseases. At the time of Hippocrates sulphur was used as a preventive against plague. While good results were often obtained by pursuing these and other such practices, the exact reasons for the results were not understood. Today, however, the bacteriologists have shown by exhaustive and conclusive experiments that certain specific disease germs are destroyed by certain disinfectants under certain conditions. They have also shown that the spores of certain bacteria will not be killed by the same processes which destroy the vegetative forms of the same species. Thus they are able to tell us that some of the ancient practices were entirely useless, others were quite unnecessary, while still others were very efficient.

More than 400 years B. C., Hippocrates advised that all polluted water should be boiled and filtered before being used for drinking pur-

poses. Today we know what constitutes dangerous pollution, and the bacteriologist tells us precisely what the processes of boiling and filtering do to this pollution in the water. He can very readily detect a polluted water by analysis, and aside from showing the presence of pathogenic bacteria, he can show the presence as well of those bacteria which come only from sewage. Along this same line bacteriology is indispensable to the sanitary scientist in testing the efficiency of water filters, both large and small. In the matter of sewage disposal, he has shown the effects of the soil bacteria in destroying the infectious material in filth which is spread over the surface of the ground, or upon filter beds; and again, in the putrefying action in the septic tank, he has shown an efficient purification.

It is now known through the researches of the bacteriologists that the typhoid bacillus and other pathogenic bacteria can and do resist the freezing temperatures for many weeks. Hence the freezing of water does not necessarily purify it of all of its disease-producing agencies.

It has been shown that the changes which occur in milk are wholly due to bacteria. Hence the bacteriologist has pointed out the necessity of bacteriological cleanliness in and about the dairies. Oftentimes disease germs may be found in the milk, pointing to the need of inspection of dairies and the careful supervision of our public milk supplies.

Putrefactive changes in meat and other foods, due to bacterial growths, result oftentimes in the production of ptomaines. Therefore care should be exercised in the sale of meat and other foods. Fruits and vegetables are known to harbor germs on their outer skins, and, when handled by infected persons, may result in spreading disease. Undoubtedly this is the source of many so-called sporadic cases of disease. Experiments have shown that the typhoid bacillus may remain alive in the stomach of the living oyster for several weeks. Serious epidemics of typhoid fever have been spread through the agency of oysters which were fattened in sewage polluted waters.

The masterly researches of Pasteur, Tyndall and Lister resulted in the protection of wounds from infection, and made it possible to undertake previously impossible surgical operations. They simply proved the presence of germs in the dust of the air, and showed the necessity of keeping this germ-bearing dust away from the vicinity of the operating table.

Bacteriology assists materially in the prompt diagnosis of many of the contagious diseases, such as diphtheria and tuberculosis, making early isolation and quarantine possible.

The old idea that consumption was a constitutional disease has been exploded. Dr. Koch, in 1882, declared this to be a germ disease. Experience has shown that there are as many as two million bacteria in a single expectoration. It is undoubtedly through the medium of the sputum that most of the consumption is spread, and these facts point out the necessity and importance of precautionary measures.

There have been many recent discoveries made by bacteriologists showing that certain diseases are due, not to bacteria, but to animal parasites, protozoa. There are many cases in which these animal parasites appear to be carried through the agency of insects. An example of this is the carrying of malaria germs by the mosquito. This has led the sanitarian to make important crusades against the mosquito, destroying their breeding places, and in this way checking a spread of the disease.

Experiments with the common house fly have shown that these insects carry infected material on their legs and probosces. Hence the need of disinfecting all germ-bearing material which may come within the reach of the fly. Also the destruction of their breeding places so as to reduce as far as possible the numbers of these insects.

The discovery of antitoxic serums, the direct or indirect products of bacterial action and growth, have been a great advance in bacteriology and medicine, not only for the curing of disease, but, more important, for protection against disease as well. The use of protective serums is now in its infancy, and I look forward to the time when the bacteriologist shall have discovered or manufactured, with the assistance of the bacteria, a serum or mixture of serums with which we may be inoculated, and thereby protected against all diseases, perhaps throughout life. That would indeed be a great factor in preventive medicine.

These facts show briefly the great and incalculable assistance given to sanitary science by one of the youngest of the many "ologies." That the sanitary scientists have taken advantage of this aid is evidenced by the attention which they everywhere receive, and the importance which is now attached to their dictum and doings. They can now compel legislation to enforce safeguards against disease, and it is a benighted

community that does not respect these measures. These measures protect the state, municipality and the home; they affect schoolhouses, public buildings, foods, and street cleaning; in fact, there is hardly a phase of social or industrial life that is not reached by the arm of sanitary precautions. Further evidence is shown by a study of vital statistics during the past fifty years, wherein may be seen a marked reduction in the deaths from all preventable diseases. All of this has come about, and much more is yet to come, I believe, through this renaissance period in the science of sanitation, marked by the establishment of the germ theory of disease and the birth of bacteriology. From that time the bacteriologist and the sanitarian have marched hand in hand in their grand fight against disease and death.

On the Use of Nickel in the Core of the Marconi Magnetic Coherer.

By Arthur L. Foley.

The magnetic detector of electric waves, described and used by Marconi,* consisted of a "core or rod of thin iron wires on which were wound one or two layers of thin insulated copper wire. Over this winding insulating material was placed, and over this again, another longer winding of thin copper wire contained in a narrow bobbin." One terminal of the inside winding was connected to earth, the other to an elevated conductor. The ends of the outside winding were connected to a telephone. A horseshoe magnet, suitably placed, was moved by clockwork so as to cause a continuous change or successive reversals of the magnetism of the iron core. Electric oscillations of suitable period appeared to reduce the effects of magnetic hysteresis, hence the magnetism of the iron core increased or decreased suddenly with each spark of the transmitter, inducing a current in the outer winding connected to the telephone. Marconi had (June, 1902) used this apparatus for some months in the reception of wireless telegraph messages over a distance of 152 miles, and with less power employed at the transmitting station than would have been required had he used a reliable coherer instead of the magnetic detector.

Marconi noticed that "the signals in the telephone are weakest when the poles of the rotating magnet have just passed the core and are increasing their distance from it, whilst they are strongest when the magnet poles are approaching the core." To obtain more definite results on this point I arranged to use a ballistic galvanometer instead of a telephone, and to take readings for various determined positions of the magnet and core.

The core, which was 5 cm. long, consisted of twenty-six pieces of annealed piano wire, .063 cm. in diameter. Over this was wound a single layer of two hundred turns of silk insulated copper wire No. 36, giving a total diameter of core and coil of approximately .4 cm. One end of the coil was connected to a vertical wire 200 cm. long; the other end was put to earth.

*Note on a Magnetic Detector of Electric Waves, by G. Marconi, Proceedings of the Royal Society, Vol. LXX, No. 463, July 29, 1902.

The outer or secondary coil, consisting of one thousand turns of No. 30 wire, was wound on a wooden spool of such dimensions that the coil itself was 1.7 cm. long and .6 cm. in diameter (inside). The terminals of this coil were connected to a Rowland D'Arsonval galvanometer through a key arranged to short-circuit the galvanometer after each throw of the needle. This brought the needle to rest very quickly, and permitted the position of the magnet to be changed without affecting the galvanometer.

The induction coil (one inch) of the transmitter was operated by a storage cell and was adjusted to give a 2 mm. spark between two small brass spheres, one connected to a vertical wire 200 cm. long, the other to earth. The distance between the transmitter and receiver was varied from two meters to twenty meters. The results given in this paper were obtained when the distance was made five meters. No effort was made to "tune" the circuits.

The magnet was made from a bar of steel 1.6 cm. square and 3.7 cm. long, bent so as to make a horseshoe magnet about 16 cm. long with parallel legs 4.8 cm. apart. The primary and secondary coils were fastened in place on a board grooved and graduated so that the magnet could be slid back and forth in the same horizontal plane with, and in a direction at right angles to, the iron core, and placed at any desired distance from it. The graduations extended from 0 to 12 cm., zero distance corresponding to contact between the ends of the magnet and the core.

To get a reading the galvanometer was first short-circuited and the magnet placed in position. The short circuit was then broken, the transmitter operated as long as the deflection of the needle was increasing, and the throw observed.

Table I gives the throws of the galvanometer for the given distances between the magnet and core.

A. When the magnet is placed 10 cm. from the core and moved one space nearer each successive reading.

B. When the magnet is placed in contact with the core and is moved one space farther from it each reading.

C. When the magnet is removed some distance after each reading and the transmitter operated before the magnet is placed in position for another reading.

D. When the magnet is turned over (the field reversed) between readings.

TABLE I.

Distance.	A	B	C	D
0.0 cm	2.0 cm.	.....	.....	7.6 cm.
0.5 "	2.3 "	0.8 cm.	4.0 cm.	7.9 "
1.0 "	2.0 "	0.9 "	3.2 "	6 1 "
2.0 "	1.3 "	1.0 "	2.0 "	3.5 "
3.0 "	0.4 "	0.9 "	1.2 "	1.6 "
4.0 "	0.3 "	1.0 "	1.0 "	1.1 "
5.0 "	0.2 "	0.6 "	0.5 "	0.8 "
6.0 "	0.1 "	0 4 "	0.3 "	0.6 "
7.0 "	0 0 "	0.3 "	0 2 "	0.4 "
8.0 "	0.0 "	0 2 "	0 2 "	0.3 "
9.0 "	0.0 "	0.2 "	0.1 "	0.25 "
10.0 "	0.0 "	0.1 "	0.1 "	0.2 "

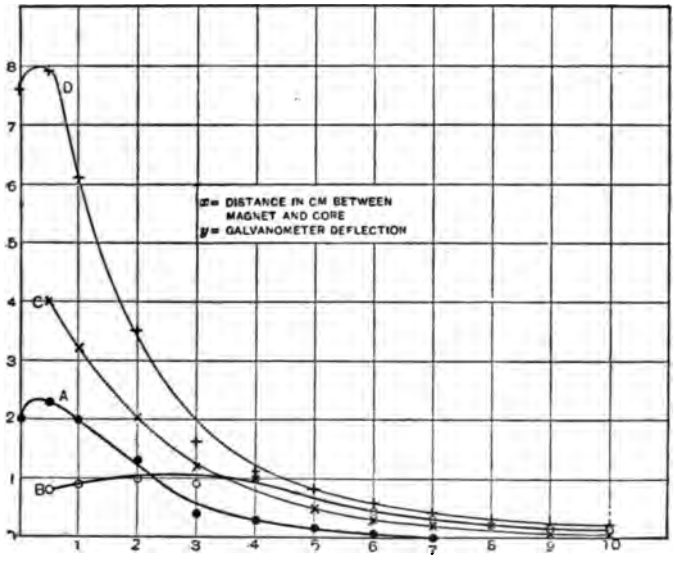


Fig. 1.

The data of Table I are plotted in Fig, 1. A comparison of curves A and B shows that the sensitiveness of the magnetic detector depends

upon both the distance and direction of motion of the moving magnet. When the magnet is near the core the detector is more sensitive when the magnet is approaching, but when some distance from the core the detector is more sensitive when the magnet is receding. Both curves indicate a maximum of sensitiveness at a distance from the core, the distance being less when the magnet is approaching than when receding.

Removing the magnet and operating the transmitter tended to demagnetize the core. Then when the magnet was placed in position and the transmitter again operated, as in Curve C, there was a relatively greater change in the magnetism of the core than was obtained under the conditions of Curves A and B. Hence the deflections in column C are greater than those in A or B. It is evident that the relative change in the magnetization of the core would be greater still where the magnetic field is reversed after each reading, as in Curve D.

Since nickel is more susceptible than iron in weak magnetic fields, and less susceptible in strong fields, it occurred to the writer that a more uniform sensibility for varying distances between the moving magnet and core might be obtained by making the core of nickel.

Four cores were made, each one being 5 cm. long, approximately .4 cm. in diameter, and being wound with two hundred turns of No. 36 copper wire.

Core 1 consisted of 26 pieces of piano wire, .063 cm. in diameter.

Core 2 of 10 pieces of piano wire and 10 pieces of nickel wire, .082 cm. in diameter.

Core 3 of 2 pieces of piano wire and 13 pieces of nickel wire.

Core 4 of 14 pieces of nickel wire.

Table II gives the deflections at various distances between the magnet and each of the four cores, the magnet being moved one space at a time and having its poles reversed after each reading. The data for three of the cores is plotted in Fig. 2.

TABLE II.

Distance.	Core 1. Fe.	Core 2. Fe & Ni.	Core 3. Fe & Ni.	Core 4. Ni.
0.0 cm	7.6 cm.	10.2 cm.	7 5 cm.	6.1 cm.
0.5 "	7.9 "	9.5 "	7.5 "	9.0 "
1.0 "	6 1 "	8.0 "	7 2 "	8.9 "
2.0 "	3.5 "	4.6 "	4.0 "	4 7 "
3.0 "	1 6 "	3.0 "	2.0 "	1.35 "
4.0 "	1 1 "	1 7 "	1.0 "	0 7 "
6.0 "	0 6 "	0.5 "	0.4 "	0 35 "
8 0 "	0 3 "	0 2 "	0 2 "	0.2 "
10.0 "	0.2 "	0 1 "	0 1 "	0.1 "

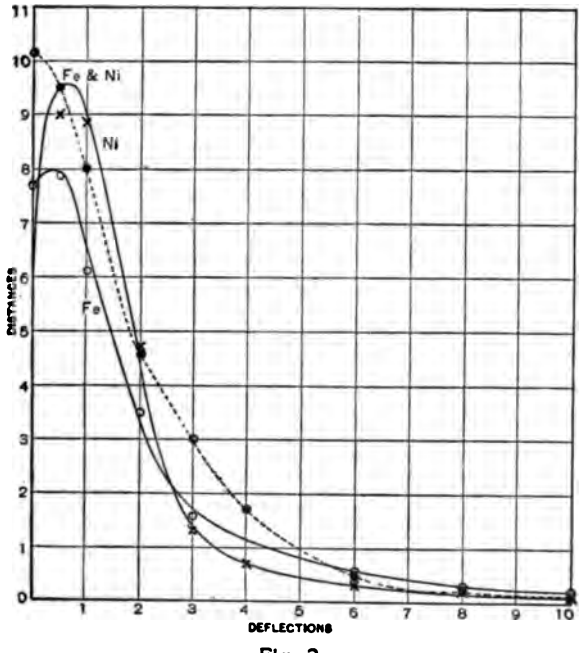


Fig. 2.

The sensitiveness of the detector with a nickel core was not very different from the sensitiveness when an iron core was used. Contrary

to expectations, however, the sensitiveness with the nickel core appeared to be the greater in strong fields and with the iron core in weak fields. Both showed a maximum of sensitiveness at a short distance from the magnet, the maximum for nickel being the farther removed. The nickel core proved to be more sensitive than the iron core for distances up to 2.5 cm.

When the detector was worked with the mixed core of iron and nickel wires the deflections of the galvanometer increased as the magnet approached the core, even up to the point of contact. The curve (Fe & Ni, Fig. 2) lies above the Fe curve at all points and above the Ni curve at most points, showing that a mixed core consisting of annealed piano wire and hard-drawn nickel wire produced a more sensitive detector than was obtained by using a core of piano wire only.

The detector gave small deflections of the galvanometer when I used an antimony core; also when I used a core of iron filings contained in a thin-walled glass tube. In both cases deflections were obtained only when the magnet was near the core. A core of bismuth gave no deflection.

It is probable that the form of the curve of Figs. 1 and 2 depends upon other points than those considered in this paper, as for instance, the frequency and intensity of the oscillations sent out by the transmitter and the annealing of the steel wires used in the core.

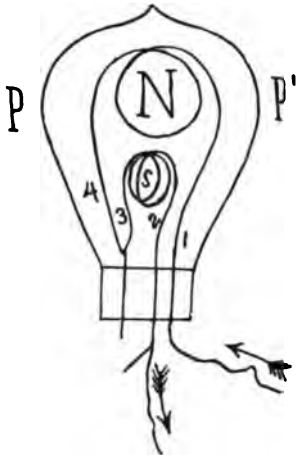
Since electric oscillations appear to "have the power of reducing the effects of magnetic hysteresis," it has occurred to the writer to test their effect upon the hysteresis loss of transformers, armatures, etc. Some experimental work on this subject has been done, but I am not yet ready to announce results.

Physics Laboratory of Indiana University, April, 1903.

The Edison Effect in a "Hylo" Lamp.

By Arthur L. Foley.

The figure is a diagram of a "Hylo" turn-down incandescent lamp in which N and s represent (when the current is in the direction indicated) the north and south ends respectively of the 16 c.p. filament (F) and the 1 c.p. filament (f), the former consisting of two and the latter of three turns. Whatever be the direction of the current the filament coils are of opposite polarity, the potential difference between legs 3 and 4 is small, and that between legs 1 and 4 a maximum. When f is burning F is in series with it, but the current is insufficient to render the latter luminous. When F is burning f is short-circuited, but has the same potential as leg 4 of F.



Let P and P′ be points on the globe at the ends of a diameter through the plane of the filaments, and NS and sn be points on the globe where the axes of the filaments F and f meet it. At P there is a deposit from one to two cm. wide, while the globe is perfectly clear on either side. At P′ the conditions are exactly reversed, the central region being dark with clear glass on each side. At n, also at s, there is a small circular deposit about half the area of a turn

of f. This deposit is surrounded by another in the form of a ring about 1 cm. wide and 2 cm. in diameter, the ring being open next the base of the lamp. Between the central deposit and the ring the glass is clear. There is no deposit within 2 cm. of the base of the lamp, and very little on the crown.

The theory of molecular shadows and the Edison Effect, so thoroughly worked out by Fleming* and others, explains the general character of the deposit, but seems to fail to explain the definiteness of it. In general the deposit is of uniform density and quite dark, while the clear places are perfectly clear, the line of separation being as definite as if the deposit had been laid on with a brush.

The weak magnetic field of the small filament was sufficient to concentrate the deposit at the ends of its axes, leaving certain regions perfectly clear. It seems that it should be possible to keep clear any desired part of the wall of a vacuum tube.

The peculiarity of the deposit above described was noticed but a few weeks since, hence the incompleteness of this investigation. An attempt to age a number of similar lamps by running at an excessive voltage resulted in a practically uniform deposit.

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*Molecular Shadows in Incandescent Lamps. Philosophical Magazine, Vol. 20, 1885.
A Further Examination of the Edison Effect in Glow Lamps. Philosophical Magazine, Vol. 42, 1896.

On the Use of Manganese Dioxide in the Generation of Oxygen from Potassium Chlorate.

By R. R. Ramsey.

The statement is sometimes made in texts on chemistry that the part played by manganese dioxide in the generation of oxygen from potassium chlorate is one of conduction only, that any other oxide, or ordinary sand, which would come in intimate contact with the potassium chlorate, would do as well. Since the black oxide, although not expensive, is more expensive than sand, the use of sand would to some extent diminish the cost of oxygen when generated from potassium chlorate.

To test this point Prof. Foley and the writer, at the suggestion of the former, made the experiments as described below.

The potassium chlorate, mixed with a definite proportion of black oxide or other material, was placed in an ordinary sheet-iron generating retort which was heated with a large Bunsen burner. The oxygen was led through a lead pipe coiled inside a calorimeter. From the calorimeter it passed through an experimental gas meter reading to 10 c.c. By this means the total volume of oxygen generated and the generating rate could be determined directly, and from the rise of temperature of the contents of the calorimeter the approximate temperature of the gas could be determined. Experiments were made with manganese dioxide, powdered silica, sand, and Venetian red.* In no case except with the manganese dioxide, did the amount of gas given off compare with that computed from the chemical formula. In fact the rate of generating, when using substances other than manganese dioxide, was so slow that calorimetric determinations could not be made. The following table will give a general view of the results:

*Equal parts iron oxide and calcium sulphate.

	Substance.	$KClo_3$	Generating Time.	Volume.		t	
				Observed.	Calculated.		
1	50 gms. MnO_2	250 gms.	8 min.	73 Liters.	74.4	22°	
2	200 " "	1000 "	18.5 "	257 "	296.5	18	Gas lost.
3	186 " Silica	930 "	24 "	56 "	273	19	Exploded.
4	500 " Sand	500 "	20 "	16.7 "	147.5	21	
5	120 " MnO_2	600 "	11 "	137.5 "	177.5	21	Gas lost.
6	65 Venetian red	325 "	25 "	21.9 "	97.6	25	

The first column gives the amount and name of substance used; 2d, amount of potassium chlorate; 3d, duration of the experiment in minutes; 4th, the volume of gas liberated as shown by the gas meter; 5th, volume of gas as calculated from mass of potassium chlorate and temperature and pressure of gas in the meter; 6th, temperature of gas in meter.

In the third experiment with powdered silica heat was applied steadily for twenty-four minutes until suddenly the delivery tube connecting the retort to the calorimeter was blown off and a stream of blazing molten silica was shot a distance of fifteen feet across the room. Upon cleaning the retort it was found that the mass of chlorate and silica had been in a foaming semi-fluid condition filling the entire retort and forcing itself through the delivery tube. In the case of sand (from the shore of Lake Michigan) heat was applied for twenty minutes with a very small amount of oxygen given off. In every case with manganese dioxide the gas had been entirely driven off in a shorter time with a flame greatly reduced from the normal. In fact a considerable amount of gas bubbled through the meter owing to the rapid rate of generation. With Venetian red a very small amount of oxygen was obtained, although the temperature was raised to the point where the entire mass was fused. Subsequent experiments performed in a test tube showed the temperature of fusion to exceed 360° C., while the temperature at which oxygen is liberated from the manganese dioxide mixture as shown by Mahin [Proc. Ind. Acad. Sci., P. 170, 1902] does not exceed 180° C. Calorimetric computations and direct observation in test tubes show the temperature of the gas to be from 65° to 100° C. It would seem that there is a lowering of temperature at liberation analagous

to the fall of temperature when water vapor is driven from a salt solution.

In conclusion, it seems that manganese dioxide serves for more than a distributer of heat, that it has a catalytic effect upon the potassium chlorate, permitting the oxygen to be liberated at a much lower temperature than when potassium chlorate is used alone. Powdered silica, sand, and Venetian red do not produce this effect, at least not to the same extent, at low temperatures, as black oxide of manganese.

Double Salts in Solution.

By P. N. Evans.

In a paper presented to this Academy four years ago, the author called attention to numerous apparent exceptions to the rule that an electrolyte is less soluble in a solution of another electrolyte with an ion in common with the first than in water alone. The evidence presented at that time was that many saturated solutions fail to give precipitates on addition of second electrolytes having ions in common with those already in the solutions.

Since that time some of the cases then noted have been further investigated, and it has been proved, as then suspected, that in these cases the electrolyte is more instead of less soluble in a solution of a second electrolyte with a common ion than in water alone.

The substances chosen were lead chloride and nitrate, and barium chloride and nitrate. The method of investigation was the determination of the solubility at zero centigrade of one compound in solutions of the other of varying concentrations up to saturation, one hundred cubic centimeters of the solution being used in each case for analysis.

Lead chloride was estimated by determining chlorine in the solution volumetrically, beginning with pure water and ending with a saturated solution of lead nitrate, after saturating with lead chloride. It was found that the solubility of the chloride increased with the concentration of the nitrate, the curve being a straight line within the limits of experimental error. The solubility of lead chloride in water was found to be 0.5426 grams in one hundred cubic centimeters of the solution; in saturated lead nitrate solution, 1.83 grams.

The solubility of lead nitrate in solutions of lead chloride was not determined, on account of the very limited solubility of the latter.

Barium chloride was estimated by determining chlorine in the solution. It was found in this case also that the solubility of the chloride increased with the concentration of the nitrate, the curve again being a straight line. The solubility of barium chloride in water was found to be 33.89 grams in one hundred cubic centimeters of the solution; in saturated barium nitrate solution, 37.42 grams.

Barium nitrate was estimated by determining barium in the pure water solution, barium and chlorine in the solutions containing chloride, and considering the excess of barium over chlorine to be present as nitrate. Again the curve was a straight line, showing an increasing solubility of nitrate with higher concentrations of chloride. The solubility of barium chloride (anhydrous) in water was found to be 5.11 grams in one hundred cubic centimeters of the solution; in saturated barium chloride solution, 9.38 grams.

These results all agree with the assumption that double salts are formed when these salts are mixed in solution, as lead chloride-nitrate and barium chloride-nitrate.

A single instance of this kind has been noticed by other observers, potassium nitrate and lead nitrate by LeBlanc and Noyes. In this instance it is interesting to note that the common ion is the anion, while in the new cases here presented it is the kathion.

These exceptions to the general rule are apparently not uncommon and deserve more consideration in the text-books on physical chemistry, where they are rarely mentioned at all.

In conclusion, the author desires to express his appreciation of the careful experimental work performed by Mr. R. W. Duncan, B.S., at that time a student in Purdue University.

Lafayette, Indiana, December, 1903.

Ionic Friction.

By P. N. Evans.

The velocity of a moving body is proportional to the impelling force and inversely proportional to the resistance offered by the surroundings. In the case of dissolved particles moving through a solution the resistance is of the nature of friction.

The movement of ions through solutions may be observed in the diffusion of dissolved electrolytes from positions of higher to those of lower concentrations, and also in the migrations of the ions during the electrolysis of solutions. The impelling force in the first case is the osmotic pressure; in the second, electric tension. The resistance in both cases is the friction against the other particles—mostly those of the solvent. That this resistance or friction is enormous is seen in the force necessary to overcome it—three hundred and two million kilograms will move a gram of hydrogen ions in water with a velocity of one centimeter per second.

It has been observed that the addition of a non-electrolyte to a solution of an electrolyte increases the resistance to the passage of the electric current. This might be due to either or both of two causes—the number of ions or carriers of the current might be diminished by the non-electrolyte's causing a partial deionization of the electrolyte, or the resistance of the solution to the migration of the ions—the ionic friction—might be increased. The second of these two hypotheses has been shown to be the correct one when only moderate quantities of the non-electrolyte are added, though the first also becomes appreciable with larger quantities.

The lines of reasoning and experiment leading to this conclusion have been of two kinds. First, the degree of ionization of the electrolyte in pure water and in water containing the non-electrolyte was determined in the usual way, based on the conductivity at some definite concentration compared with that at infinite dilution and found to be the same when moderate quantities of the non-electrolyte were present. Second, the increase in the resistance to the passage of the electric

current and to the movement of ions by diffusion due to osmotic pressure has been found to be approximately proportional to the increase in internal friction measured by the rate of flow through a capillary, indicating friction as the immediate cause.

The purpose of the investigation here reported was to attack the problem by a method not hitherto used apparently in this connection. The freezing point method was employed, and the solutions examined were those of hydrochloric acid and sucrose. The freezing points determined were those of water, of twice-normal and twentieth-normal water solutions of hydrochloric acid, of water solutions of sucrose containing 1, 5, 10, 25 and 35 grams in 100 cubic centimeters, and of water solutions of hydrochloric acid and sucrose of corresponding concentrations. The ordinary Beckmann apparatus was used.

It was found that the lowerings of the freezing point produced by known weights of acid and sugar mixed in a given quantity of water was equal to the sum of the lowerings produced by the same weights of acid and sugar each dissolved separately in the same quantity of water. This result harmonizes with those found by the other methods mentioned above in showing no effect of the sugar on the degree of ionization of the acid, and leading to the conclusion that the increase in resistance to the current observed in corresponding solutions of hydrochloric acid on addition of sugar, was due wholly to an increase in the friction between the ions and the solutions.

The author desires to express his appreciation of the experimental work done by Mr. H. E. Bachtenkircher, B.S., at that time a student in Purdue University.

Lafayette, Indiana, December, 1903.

A New Problem in Hydrodynamics with Extraneous Forces Acting.

By Edward Lee Hancock.

The solution of most problems in hydrodynamics depends upon the proper combination of the equations of motion of the fluid interior of a given closed surface with the differential equation of the surface, or with the equations expressing the boundary conditions.

Lord Kelvin has shown that the differential equation of the surface for both compressible and incompressible fluids has the following form:

$$u.F'(x) + v.F'(y) + w.F'(z) + F'(t) = 0$$

where (t) is a variable parameter of the equation

$$F(x, y, z, t) = 0.$$

In the treatment of problems of the motion of incompressible fluids in three dimensions, where the surface under discussion is spherical or nearly so, the usual particular solutions of Laplace's equation ($\nabla^2 v = 0$), such as, zonal, tesseral and spherical harmonics, are adequate, since in these cases the velocity-potential satisfies Laplace's equation. The solution used in any particular case depends upon the symmetry of the boundary conditions. Where the surface differs much from the spherical form as in ellipsoids, ellipsoidal harmonics are used. Problems of this kind have been extensively investigated.

In discussing the anchor ring Mr. W. M. Hicks[1] has derived modified forms of the zonal, tesseral and spherical harmonics by means of which the potential both outside and inside the ring may be completely investigated. The same problem has been solved by Mr. F. W. Dyson[2] by using elliptic integrals.

The problem is much simplified when the motion takes place in a single plane, in which case, if the boundary consists of a straight line, two parallel straight lines, or is rectangular, the velocity-potential may be expressed as a Fourier's series or a Fourier's integral.

1. Phil. Trans. 1893.
2. Phil. Trans. 1881, Part III.

In other cases there is no direct method of procedure. The inverse process of finding what boundary conditions will give known solutions of Laplace's equation is used, with the hope of finding the desired solution. The method of images is also applicable to some cases, more especially perhaps in the case of rotational motion.

For the irrotational motion of a perfect liquid there always exists a velocity-potential which satisfies the equation

$$\nabla^2\varphi = 0.$$

The potential φ and the rectangular velocities u, v and w may be found from the given conditions, for all points of the interior. The potential being always least at the boundary the lines of flow and equipotential lines begin and end there. This is true whether the motion is "steady" or not and true, therefore, when the extraneous force is gravity.

Much work has been done on the motion of many of the regular solids immersed in a liquid, when acted upon by a system of impulsive forces and also by constant forces. The motions of the liquid in the neighborhood of such solids has also been discussed. Both tidal waves and waves due to local causes have been investigated and their properties discussed to some extent. The related problem of the effect of high land masses upon neighboring bodies of water has been worked out by Professor R. S. Woodward and others.

Perhaps the most familiar problem of the effect of an extraneous force upon a body of liquid, is the "Torricelli Theorem" on the efflux of a liquid from an aperture in the side or bottom of the containing vessel. There the vessel is kept filled to a constant level the motion becomes steady making $\frac{du}{dt}=0$, $\frac{dv}{dt}=0$ and $\frac{dw}{dt}=0$; and giving the well-known result $q^2 = 2gz$, where q is the velocity. In case the liquid rotates under the influence of gravity angular velocity is introduced, giving $\frac{dv}{dx}-\frac{du}{dy}=2w$. Showing that a velocity potential does not exist, and that such motion could not take place in a perfect liquid.

Cases of motion where no extraneous forces are acting have been completely worked out by methods of conjugate functions and the theory of images. In these cases the lines of flow and equipotential lines are orthogonal systems of curves, and methods of plotting such are easily devised. But when extraneous forces are acting these lines no longer

belong to orthogonal systems of curves and no method has yet been devised by means of which the lines could be drawn under specified conditions.

It was hoped that some graphical method applicable to all cases might be found in connection with the present work, but thus far none has been discovered that is at all general. I have found the equipotential lines and lines of flow for a rectangular area where a constant extraneous force is acting.

Taking the liquid as incompressible since the external forces is constant the motion is steady and the velocity potential may be made to satisfy the equation

$$\frac{\delta^2\varphi}{dx^2} + \frac{\delta^2\varphi}{dy^2} = 0$$

$$\text{and } \frac{\delta\phi}{\delta x} = ku, \quad \frac{\delta\varphi}{\delta z} = kw.$$

A constant must be added to one of these velocities to express the effect of the constant force. This is more clearly seen perhaps in the case of vertical motions due to the force of gravity. In this case the constant to be added to w is of course g and since this is a constant Laplace's equation is still satisfied. The lines of flow and equipotential lines are no longer orthogonal, but are, as we shall presently see, inclined at different angles, being tangent at some points of the interior.

If the area be taken in the sphere of attraction of the earth and near enough so that the attraction may be taken as constant we shall have

$$u = k\frac{\delta\phi}{dx}$$

$$v = k\frac{\delta\phi}{dz} + k\rho g.$$

where ϕ satisfies Laplace's equation.

Professor C. S. Slichter[1] has shown that the motions in an area A B C D, Fig. 1, filled with sand and having water flowing through it, entering along A B and flowing out along A D—the sides B C and C D being impervious—may be fully discussed by replacing the sand and water by a perfect liquid having a velocity potential, and that the velocity potential in this case would be identical with the pressure function. This being true, it is possible to find the pressure at any point in the interior as well as the component velocities at these points, just as soon as the

1. 19th Annual Report, U. S. Geological Survey, Part II.

boundary conditions are known. Accordingly in what follows the velocity potential will be replaced by the pressure function.

If the section be horizontal, the problem may be treated in the usual way, but in case the section is vertical the extraneous force, gravity, gives a system of curves which are not orthogonal.

Let D C = a and A D = b, and suppose the head of water along A B zero. The boundary conditions then to be satisfied are:

$$P = 0 \text{ when } x = 0$$
$$P = 0 \text{ when } x = a$$
$$P = h \text{ when } z = b$$
$$w = 0 \text{ when } z = 0$$

And since the area is a rectangle P, u and w are expressed as Fourier's series:

$$P = \frac{4g\rho a}{\pi^2} \sum_{n=1}^{n=\infty} \frac{\sinh \frac{n\pi(b-z)}{2a}}{n^2 \cosh \frac{n\pi b}{2a}} \cdot \sin \frac{n\pi x}{2a}$$

This differentiated with respect to x and z for u and w gives:

$$u = \frac{4g\rho k}{\pi} \sum_{n=1}^{n=\infty} \frac{\sinh \frac{n\pi(b-z)}{2a}}{n \cosh \frac{n\pi b}{2a}} \cdot \cos \frac{n\pi x}{2a}$$

$$w = \frac{4g\rho k}{\pi} \sum_{n=1}^{n=\infty} \frac{\cosh \frac{n\pi(b-z)}{2a}}{n \cosh \frac{n\pi b}{2a}} \cdot \sin \frac{n\pi x}{2a} + g\rho k$$

In the above equations n represents each of the successive odd numbers, a and b being the sides of the rectangle may have any desired value. But for simplicity they were in the present case taken equal to ten, and for the same reason $g\rho k$ was taken equal to unity.

Making these changes the equations become:

$$P = \frac{80}{\pi^2} \sum_{n=1}^{n=\infty} \frac{\sinh \frac{n\pi(10-z)}{20}}{n^2 \cosh \frac{n\pi}{2}} \cdot \sin \frac{n\pi x}{20}$$

$$u = \frac{4}{\pi} \sum_{n=1}^{n=\infty} \frac{\sinh \frac{n\pi(10-z)}{20}}{n \cosh \frac{n\pi}{2}} \cdot \cos \frac{n\pi x}{20}$$

$$w = \frac{4}{\pi} \sum_{n=1}^{n=\infty} \frac{\cosh \frac{n\pi(10-z)}{20}}{n \cosh \frac{n\pi}{2}} \cdot \sin \frac{n\pi x}{20} + 1$$

From these equations the values of P, u and w were found at each of the one hundred points given in the area. This was done by computing the series for x = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 when z = 1, and then when z = 2, 3, 4, 5, 6, 7, 8, 9, 10, i. e., by making one hundred computations of each series. The value of u and w being found for each point it was not difficult to determine the resultant in both magnitude and direction. This gave the flow at each of the points of the area. We find from Fig. 1 that there is actual motion throughout the whole area.

The motion, indeed, at some points is very slight, but there is no point in the entire area where there is no motion. This is important if we regard this as an immense area in homogeneous ore-bearing rock. It indicates that at every point of the area the water is continually moving and coming into contact with new rock surfaces, thus increasing its capacity for dissolving the mineral salts from the area. From the length and direction of the arrows it is seen that at the corner D the lines are crowded down closer together than at A. This shows that the constant force gravity has distorted the field, causing the lines of flow to be concentrated at the bottom, and showing that underground waters must take very long journeys before reaching their destination and so come in contact with a very great area of rock surface.

As before stated, the relations of the equipressure lines to the lines of flow differ from that found in horizontal planes. From Fig. 1 it is seen that the angle between the systems of curves varies from nearly a right angle to two right angles, that is, to tangency. In fact, there is in the area what may be called a line of tangency meeting the sides A D and D C. These lines of flow as before indicated taken at equal distances along A B crowd near each other down near D, showing the effect of gravity upon them. If we cause the constant force g to cease to act in the case under consideration, the lines of flow would be arcs of circles cutting A B and A D at equal distances from A. The effect of

gravity then is to pull these arcs of circles out into cycloidal-like curves crowding near D C. As a matter of fact the curve drawn from $x = 5$, $z = 10$ is nearly a cycloid. Those in the upper left-hand corner being too low and long and those in the lower right-hand corner too short and high for cycloids.

The lines of pressure are hyperbola-like curves drawn for pressures, 1, 2, 3, 4, etc., all the curves beginning and ending in the boundary.

It is easy to see that we may take a similar area a b to the right of A B C D and leaving an open face similar to A D and an impervious bottom and water at zero pressure along the top. We should then have these two areas one on each side of B C with the liquid flowing in opposite directions. The liquid in each area flows directly down B C and so the motion will not be interrupted if B C be removed. That is, the method of images is applicable horizontally. If, however, a similar area to A B C D be taken just below C D we can not say that the method of images as usually applied holds true. We may regard A D in the upper area as an absorbing slit and A D in the lower area as a similar slit and the position C D between them as a mirror the corresponding parts of A D in the upper and lower slits are not found at equal distances above and below C D. They are found drawn down by gravity so that the method of images must be modified for vertical distributions. By integrating u with respect to z between the limits b and $\frac{9}{10} \cdot b$; $\frac{9}{10} \cdot b$ and $\frac{8}{10} \cdot b$, etc., the amount of flowage from each of the ten equal divisions of A D may be calculated. And in a similar way the amount of liquid going in at each of the ten equal divisions of A B is obtained by integrating w with respect to x between the limits a and $\frac{9}{10} \cdot a$; $\frac{9}{10} \cdot a$ and $\frac{8}{10} \cdot a$, etc. The equations for the flowage and the amount absorbed are then:

$$f = \int_c^d u\,dz = \frac{8ag\rho k}{\pi^4} \sum_{n=1}^{n=\infty} \frac{\cosh \frac{n\pi(b-z)}{2a}}{n^2 \cosh \frac{n\pi b}{2a}} \cdot \cos \frac{n\pi x}{2a} \Big]_c^d$$

$$a = \int_c^d w\,dx = \frac{8ag\rho k}{\pi^2} \sum_{n=1}^{n=\infty} \frac{\cosh \frac{n\pi(b-z)}{2a}}{n^2 \cosh \frac{n\pi b}{2a}} \cdot \cos \frac{n\pi x}{2a} \Big]_c^d g\rho kx \Big]_c^d$$

where c varies from $\frac{9}{10}$. b or $\frac{9}{10}$. a down to zero, and d varies from a or b down to $\frac{1}{10}$. b or $\frac{1}{10}$. a. Solving the ten equations for the ten different values of f and a, we get the following table:

No....	1	2	3	4	5	6	7	8	9	10
a	.958	.875	.800	.726	.664	.611	.566	.535	.512	.502
f	.042	.126	.216	.315	.424	.556	.716	.935	1.24	2.07

TABLE I.

It will be seen from the table by counting the divisions from A as 1, 2, 3, etc., that nearly half the water flows through the first three divisions and that there is a gradual decrease toward B. The relative value of f from the different divisions shows a very slight flowage from the first division with a rapid increase from each of the succeeding divisions until the two lower divisions at D carry off one-half of the amount absorbed. This shows in a very vivid way the pronounced effect of gravity or any constant external force upon a liquid. The amount going in along A B is of course equal to the amount flowing out along A D, since the equation of continuity must hold true.

It is interesting to note that the curve given by plotting the flowage from A D is very nearly a tractrix or antifriction curve. See Fig. 3. It would undoubtedly be an exact tractrix had the number of divisions of A D been taken small enough, i. e., if twenty or thirty equal divisions had been taken instead of ten.

In Fig. 3 the line O X corresponds to the distance A D in Fig. 1, and the y-coördinates of the curve are given by the values f taken from Table I.

Fig. 4 shows the distribution of absorption into the area A B C D along A B, the line A B of the figure corresponding to the line A B of the area. The y-coördinates of the curve being taken from Table I as the different values of a.

Figs. 3 and 4 then show the distribution of absorption and flowage along A B and A D.

Extending this method by taking A B one hundred and keeping A D ten, we get approximately an artesian well area. The values of f and a for this case are given below:

No....	1	2	3	4	5	6	7	8	9	10
a	5.51	1.44	.139	.044	.028	....	....	....	....	.005
f	.040	.162	.210	.348	.446	.616	.762	.981	1.32	2.53

TABLE II.

It will be seen that the amount flowing in at the first division of A B is about two-thirds the total amount flowing into the entire area, and that this supplies the flowage for the first nine divisions of A D while the tenth division of A D gives out the water from $\frac{9}{16}$ the distance A B. If the rock in the area be soluble it is easily seen that the water flowing from this lowest division of A D will be very highly charged with mineral matter, while the remaining two-thirds that flows out above will be very slightly charged. This is more especially evident when the long sweeping paths of the water are considered compared with the very short paths of the waters of the first division of A B. We have this represented graphically in Fig. 5, where the lines of flow are drawn for the case where A B = 100 and A D = 10, or a typical artesian area. If A D be a crevice in the rock it is evident that this place will be favorable for the deposition of the mineral salt dissolved in the water since the pressure is released at this point and there is apt to exist some reagent that will cause a precipitate of the ore. This reagent may exist in the crevice itself or in the opposite wall.

In Fig 6 the curve has been plotted for the flowage from A D for the case A D = 10 and A B = 100. This does not differ much from the case where A D = 10 and A B = 10, except that the convexity downward is somewhat more pronounced, making the curve less like the tractrix.

Ten equal divisions were taken along A D and the values of y taken from Table II corresponding to different values of f.

The absorption curve for the case A D = 10 and A B = 100 is given in Fig. 7. Here the scale has been somewhat changed due to the large value of A B. The distance A B was divided into one hundred equal divisions, while the same vertical scale was used for y as in the preceding cases. The values of y were taken from Table II, being the different values of a in that table.

The rapid fall of the curve at first and then more gradual fall corresponds to the values of a found in Table II and also emphasizes the relative slowness of the motion of the water in the right-hand half of the area A B C D, Fig. 5, as compared with that of the left-hand half.

The method used in the preceding cases might be extended to areas of different dimensions, but the results would not differ much from those already stated.

If A B be taken greater than one hundred, while A D remains ten, or if we have any similar relation between the two, it will be more advantageous to use the Fourier's integral instead of the Fourier's series, since for such a difference between A B and A D the area may be considered as an infinite strip.

The results obtained are especially interesting in connection with the motion of ground water, because of their bearing on the theory of ore deposits, artesian wells and drainage flumes. The fact that sand through which water is flowing, as before indicated, can be replaced by an ideal liquid having a velocity-potential which is identical with the pressure opens a new field of investigation in hydrodynamics from which many important results will be obtained.

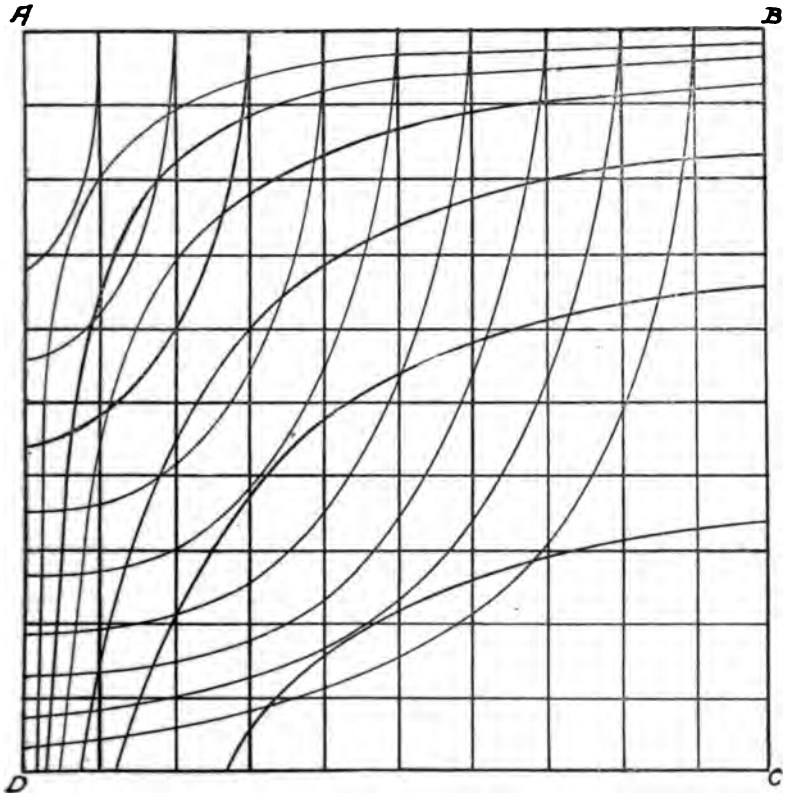

Fig.-1

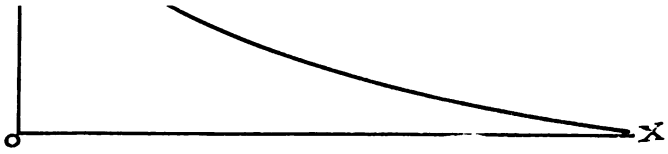

Fig. — 4

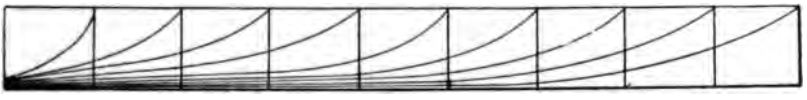

Fig.-5

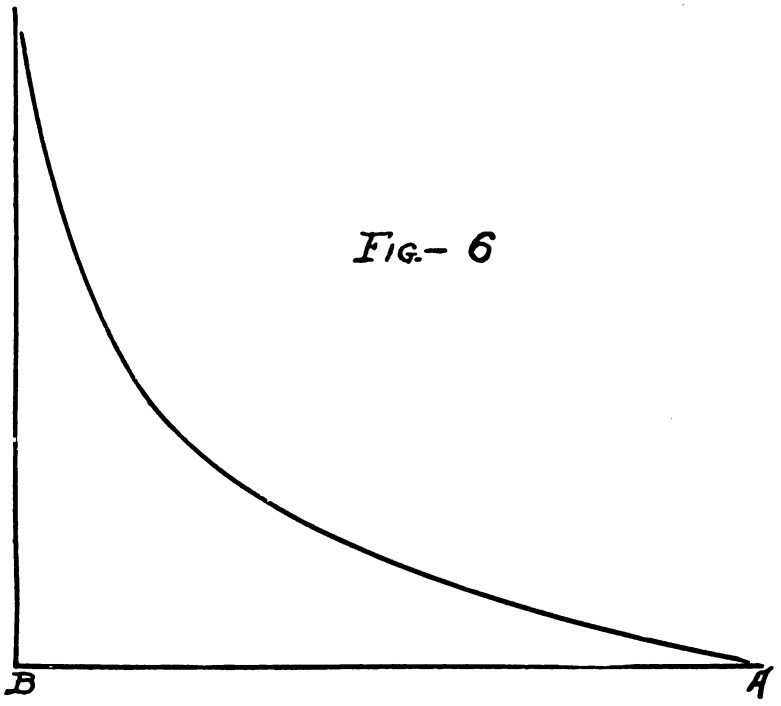

Fig.- 6

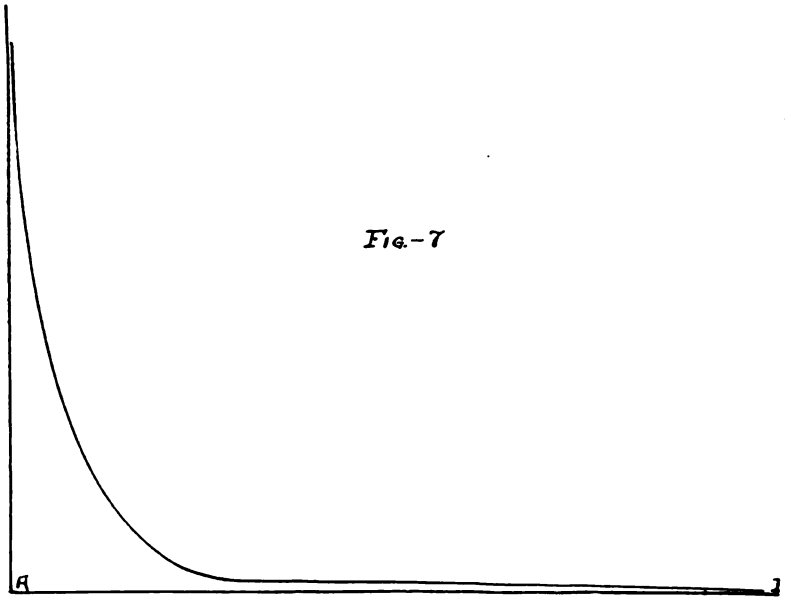

Fig.-7

A Topographic Result of the Alluvial Cone.

By A. H. Purdue.

An alluvial cone that is composed mainly of more or less finely comminuted material would not last long enough after the area covered by it ceases to be one of deposition to produce an enduring topographic feature. It would soon succumb to the agents of erosion and transportation. Even if composed of coarse material, its life might be short if the lithological character and climatic conditions were such as to bring rapid disintegration. But if the cone be composed mainly of coarse material that can withstand the weathering agencies, there is every reason to believe that it would have lasting topographic results.

In transverse section, alluvial cones are higher in the middle than on the borders next the escarpment, as shown in Fig. 1, so that the tendency

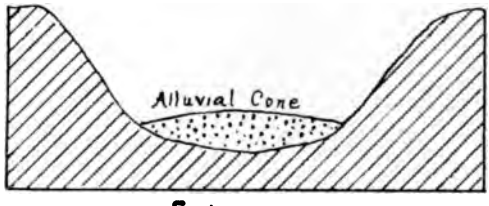

Fig. 1.

is for the streams which form them to shift either to the right or to the left, running along the base of the escarpment. If such a stream is not overloaded at this point, it becomes a cutting stream, and the profile, that

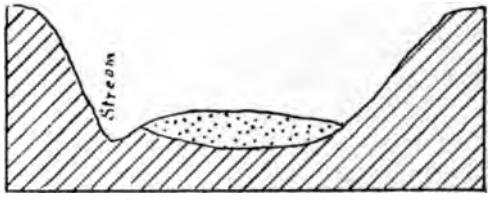

Fig. 2

shown in Fig. 2. Should the cone be formed immediately below the junction of two streams, as in Fig 3, both streams might shift, one to either

A Topographic Result of the Alluvial Cone.

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An alluvial cone that is composed mainly of more or less finely comminuted material would not last long enough after the area covered by it ceases to be one of deposition to produce an enduring topographic feature. It would soon succumb to the agents of erosion and transportation. Even if composed of coarse material, its life might be short if the [illegible] character and climatic conditions were such as to bring rapid destruction. But if the cone be composed mainly of coarse [illegible] that can withstand the weathering agencies, there is every reason to believe that it would have lasting topographic results.

In transverse section, alluvial cones are higher in the middle than on the borders next the escarpment, as shown in Fig. 1, [illegible]

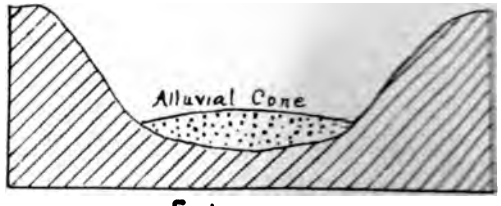

Fig. 1.

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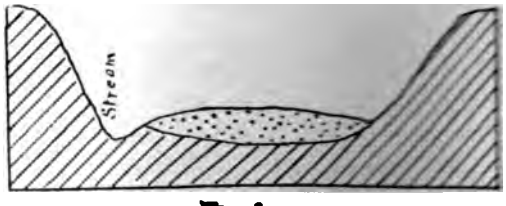

Fig. 2

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Fig. 3

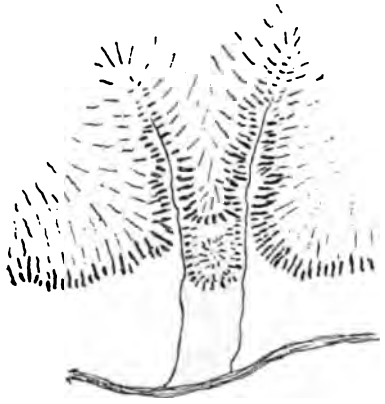


Fig. 4.

side, leaving the cone between them, as in Fig. 4, and with the profile as shown in Fig. 5. The writer has in mind a case of this kind, where the shifting has recently taken place.

Fig. 5.

In the Boone chert region of northern Arkansas, there are many alluvial cones, composed almost entirely of fragmentary chert. This chert withstands weathering to a remarkable degree. It readily permits the rainfall to pass through it, thus preventing erosion, and forming an ideal protection for the underlying rocks.

Also, over this region, there are numerous knobs of the character shown in Fig. 6. These knobs are capped with fragmentary chert, resting upon the magnesian limestone that underlies the Boone chert. The sur-

Fig. 6

rounding geography is that shown in Fig. 4. Nearly all the capping material is angular, but close search will often reveal water-worn pebbles.

The writer is of the opinion that the capping material is that of alluvial cones, and that the preservation of the rock beneath from erosion, is due to the protection afforded by the cones. Such knobs are sometimes 500 feet above the valleys beneath. The small number of water-worn pebbles is accounted for in the fact that the débris of the cones was transported but short distances, and there was not time for much rounding. Besides, the material is hard, and would wear slowly.

The material of these old cones must not be confounded with the gravel that is common in this region, and which occurs on the hill sides (see Fig. 6) often extending up to the height of 200 feet or more above the present stream level. This material, unlike that capping the knobs, is all water-worn, and was left on the inside curve of the streams as they shifted laterally.

Progress in Locomotive Testing.

By W. F. M. Goss.

It is now fourteen years since the initial steps were taken to install at Purdue University a locomotive testing plant. Plans which were then formulated were rapidly worked out, and in the fall of 1891, the completed plant was put into operation. It consists of a mounting mechanism, upon which any locomotive can be operated in much the same manner as upon the road, while retaining its fixed position in the laboratory; and of such accessory apparatus as is needful in measuring its power and in determining its efficiency. A locomotive mounted upon the testing plant can be fired as if upon the road and can be run at any speed and under any load, its action being controlled in precisely the same manner as when in actual service, while its fixed position in the laboratory allows the attachment of delicate apparatus, and permits great accuracy in the methods employed in studying its performance.

The practical value of the Purdue plant was at once recognized. It had long been understood that in testing a steam engine, the maintenance of constant conditions was of prime importance, whereas the operation of a locomotive on the road is attended by a great variety of changes in conditions which affect its action. Again, upon the road, so great are the limitations governing the attachment of apparatus that observations had necessarily been of a very elementary sort. Difficulties in testing arising from these and other causes were entirely overcome by the advent of the testing plant. By its use it became possible to apply to the locomotive the same accurate methods in observing the performance of a locomotive which had previously been elaborately developed for testing stationary engines. Mechanical engineers and superintendents of motive power visited the laboratory to witness the operation of the Purdue testing plant, from many parts of our own country, and from several foreign countries. Other plants were soon proposed. In 1896 the Chicago & Northwestern Railway Company equipped its Chicago shops for locomotive testing, and more recently, Columbia University has supplied a locomotive testing plant for its engineering laboratory. Other institutions have plants in contemplation. Meanwhile, the work of the Purdue plant has proceeded

steadily from the beginning. Besides serving in the instruction of hundreds of students, it has supplied the means for conducting a number of important researches, the results of which have been duly published and important problems are now in process of solution under the patronage of the Carnegie Institution. This, while in terms too brief to be entirely complete, gives a fair picture of the present status of locomotive testing from a laboratory point of view.

Just at this time, all who are interested in locomotive design or performance have their faces turned to the Louisiana Purchase Exposition. Engineers have always looked upon a great exposition as serving in many ways to advance the practice of their profession. It has often happened that in addition to the far-reaching influence of their general exhibit, such expositions have given occasion for a considerable amount of highly scientific work. At the Centennial Exposition at Philadelphia, in 1876, a system of steam-boiler testing was developed. The Columbian Exposition at Chicago in 1893 had its engineering congress, and it is of interest to know that the Louisiana Purchase Exposition at St. Louis is to be emphasized by the working out of extensive plans for locomotive testing.

It has been announced that the Pennsylvania Railroad Company is to make a locomotive testing plant the central features of its exhibit at St. Louis, and is to conduct tests upon locomotives throughout the period of the Exposition. To this end, it is now installing in the Transportation Building at the Exposition, an elaborate and most beautifully designed testing plant. The undertaking is being directed by Mr. F. D. Casanave, acting as special agent in charge of the company's exhibit, with whom the various technical departments of the railroad are co-operating. That the work of testing locomotives may be free from all taint of selfishness, and that it may serve as large a purpose as possible, the company has invited the American Society of Mechanical Engineers and the American Railway Master Mechanics' Association to have a part in giving direction to its work. Each of these organizations, in accepting the invitation has appointed a committee of three to represent it, which committees, acting together, constitute what is now known as the Advisory Committee of the Pennsylvania Company for Locomotive Testing. The writer's connection with the work is that of a member of the Advisory Committee.

It has been planned to test twelve locomotives, a number of which will be of foreign manufacture. One is to be a de Glehn balanced compound, which has been ordered by the Pennsylvania Company and will

be imported from France for use on the testing plant. German manufacturers are to send locomotives equipped with superheaters. The coming to this country for the purpose stated of these typical foreign locomotives is a matter of more than ordinary significance. The American locomotives selected for test will represent different types of modern freight and passenger engines.

It is expected that a test will be started each day between eight and nine o'clock in the morning, and will be continued for from two to four hours, depending upon the conditions of running. Any engineer, therefore, interested in locomotive testing may see a test in progress by visiting the Transportation Building during any morning of the Exposition.

It is proposed to have the results obtained from all the tests given publicity by means of bulletins, which will be issued from time to time by the Pennsylvania Company, and which will be sent to the technical press and to individuals under conditions yet to be announced. Bulletin No. 1, describing the organization and the methods has already been issued.

Additions to the Flora of Indiana.

By Herman B. Dorner.

The plants given in the list below, are some which were collected, by the writer within the past three years, and have not, as yet, been included in the State flora.

It was thought best, in presenting this list, to add such notes as might be of interest to botanical workers of the State.

The nomenclature used is that of "Britton's Manual of the Flora of the Northern United States and Canada."

1. *Panicum Columbianum* Scribn. Tippecanoe County.

Collected, in 1902, along the Wabash Railroad east of Lafayette.

2. *Panicum Lanuginosum* Ell. Tippecanoe County.

This species was collected, during the season of 1902, in three localities. It was first collected along the Wabash Railroad, east of Lafayette, and again on a wooded hillside about three miles east of the city. The third collection was made about three miles north of the city, along a shaded roadside.

Britton gives as the range of this species, "from southern New Jersey to Florida and Alabama."

3. *Panicum oligosanthes* Schult. Tippecanoe County.

This was first collected, in 1901, along the Wabash Railroad east of Lafayette. Observations in this locality, during the succeeding years, show that it is gradually spreading over more territory.

In 1902, it was again collected south of the city, along Wea Creek.

Britton gives for its range, "Virginia to Georgia and Mississippi." Its introduction into the State is probably due to the railroads.

4. *Sporobolus longifolius* (Torr.) Wood. Tippecanoe County.

This occurs in Tippecanoe County in several localities. It was first collected south of Lafayette, along the banks of Wea Creek. Later it was found on a dry, open hillside, about three miles east of the city.

It is quite abundant where found.

5. *Bromus patulus* M & K. Tippecanoe County.

Quite common on Purdue farm and on State Street, West Lafayette.

All attempts to determine this species referred it to *B. squarrosus* but the description did not seem to fit it. Specimens were then sent to Prof. Hitchcock who determined it as *B. patulus* M. & K. In regard to it he

says, "It is allied to B. *squarrosus*, but has a more loose and open panicle. It is not described in the manuals, as it seems to be introduced in only a few places in this country."

A description of this species will be found in Mr. Shear's "Revision of the Genus Bromus," published as bulletin 23 of the Division of Agrostology.

The plant seems to be well established in this locality.

6. *Hordeum pusillum* Nut. Tippecanoe County.

This species was collected along the Wabash Railroad, east of Lafayette, where it seems to be well established.

It was first collected in 1900 and specimens have been taken each succeeding year.

This species was probably introduced in refuse, thrown out from cattle-cars.

7. *Tradescantia brevicaulis* Raf. Tippecanoe County.

Found very commonly, about Lafayette, on partly shaded hillsides.

8. *Asarum acuminatum* (Ashe) Bicknell. Tippecanoe County.

Very common in woods and on shaded hillside, east of Lafayette. *A. Canadense* F. with which it is confused was also found in the same locality.

9. *Allionia linearis* Pursh. Tippecanoe County.

First collected along the Wabash Railroad in 1901. Observations since then show that it has become well established and is slowly spreading.

10. *Geranium pusillum* Burm. f. Tippecanoe County.

In the summer of 1902, this was found growing among the grass on the Experiment Station grounds.

This one collection, however, without any additional observations is hardly enough to admit it to the State flora.

11. *Androsace occidentalis* Pursh. Tippecanoe County.

Found growing somewhat abundantly in lowland near Wea Creek.

This is listed on page 606, of the Catalogue of the Flowering Plants of Indiana, by Prof. Coulter, as a doubtful member of the State flora.

Specimens of all the plants listed above have been deposited in the herbarium of Indiana plants at Purdue University.

In conclusion, the writer wishes to acknowledge his indebtedness to Prof. Stanley Coulter, for much kind help in his work, and to Prof A. S. Hitchcock, of the Department of Agriculture, for help in the determination of the grasses.

Botanical Notes.

By Moses N. Elrod.

Tecoma radicans (L.) D C. The trumpet-flower presents many peculiar characters that are of great value in securing cross-fertilization, and it seems to be constructed on a plan admirably adapted to meet the needs of the humming-bird.

One among the first things in its structure to attract attention is the nearly horizontal position of the flower, its short, unexpanded lower lip, the opposite of the arrangement in many flowers dependent upon insect visitors for fertilization, and the manner in which the filaments are twisted right and left so as to bring the dehiscing anther on the same plane with their backs against the upper lip of the corolla. This grouping of the anthers is effected by the outer and longer pair of the angular, dimorphous filaments making one turn on their axes and the inner pair making a half turn. The pistil is a little longer than the stamens and terminates in a two-branched, foliaceous, spatulate stigma.

In July, 1902, I noticed that the stigma is sensitive. While searching in my pocket for a magnifying glass the lobes of a plucked flower had closed so that the stigmatic surfaces were in close contact. The use of force failed to separate them for more than a moment and when one of the thin lobes was cut away the other curled up into a loose roll. At the time, I supposed that I had made a discovery, but soon found that I had been anticipated. In Müller's "Fertilization of Flowers" it is stated that when the stigma of *Bignonia* has been "touched by an insect visitor they then close up immediately." He also quotes the experiments of his brother on a South American species, showing that successful fertilization was secured only when the pollen applied came from a plant growing "at a distance." It was to test the sensitiveness of the stigmas and the conditions under which cross-fertilization was effectual that my observations of *Tecoma radicans* were made.

The stigmatic lobes of a flower which had just come into bloom, when irritated with the point of a knife-blade or any other hard substance, closed in five seconds, and those of the faded flowers in thirty seconds. A drop of water acted as an irritant when applied soon after the stigmas

had matured, but a warm rain had no effect. Fresh flowers placed in a refrigerator were not affected by the reduction of the temperature, while those exposed to cold rains seemed to have their irritability diminished. The application of pollen from the same or another flower had no effect when care was exercised not to roughly touch the stigma. Pollen was applied one evening to the tip of the lower lobe, which is the larger and longer of the two lobes, and it did not hinder their opening next morning. After closing up from the use of an irritant alone they opened again in about two hours. But if the irritation had been accompanied with the application of pollen from the same or another vine they rarely opened again, and never if the ovary was fertilized.

More than fifty experiments to determine the effects of pollenization with pollen from the same flower as the stigma treated, or from another flower growing on the same stock, gave negative results. In some cases the ovary seemed to swell and remained attached to the vine longer than those not pollenated, but they all turned black or dropped off within fifteen days.

All the stigmas treated, to determine their irritability, and the effects of pollen applied to them coming from a distance, grew on vines in the back yard of No. 823 Washington Street, Columbus, Indiana. Six strong stocks, coming from the same root, cover the fence and an old apple tree. In the autumn of 1901 they produced many matured capsules. August the 19th and 20th, 1902, eleven stigmas were pollenated from flowers collected two and one half squares distant. Six of these began to develop in fine style, but came to naught. September 9th and 10th, six stigmas were treated with pollen from a vine found growing outside the city limits, one-fourth mile west on the Nashville road. As a result, the ovary, in one instance grew to be one inch long and then withered. The others were failures and their ovaries did not appear to have grown a little bit. The season closed with nothing to show for my work and the distance theory unverified. The vine in my yard began blooming again July 1st, 1903, and the first experiment of that year was made to see how much influence the soil in which the vine grew had to do in determining the final results of cross-fertilization. July 5th, I collected flowers from a vine growing in the rich bottom land of Clifty Creek, two miles south of the city, and twenty stigmas growing in my yard were pollenated. The flowers treated, were in all stages of blooming, from those just opening to others that were fading, but none where the lobes of the stigma did not promptly

close when irritated. These experiments resulted in twelve full grown capsules. July 31st and August 2d eighteen stigmas were pollenated from flowers found growing on clay soil, one mile south of the city, which resulted in three mature capsules. August the 14th and 18th, nineteen stigmas were treated with pollen from a vine growing in clay soil one-half square north of my vine, and three mature pods were the result. Ten stigmas were pollenated August 19th from a vine growing in clay soil, at the root of a large elm tree, about one square northwest of the home vine, and eight mature capsules were the result.

Summarized, the results show that sixty per cent. of the pollenations made with pollen from a vine growing in rich loam were successful; fifteen and sixteen per cent. were successful when the pollen came from clay soil, and the vines grew in the open, under conditions nearly the same as that of my back yard, and eighty per cent. as the result when the pollen came from a vine whose roots were planted in clay soil and entertwined with those of a big elm. From this it seems that the soil in which the vine grows, has some influence on the fertilizing power of its pollen. The pollen used in the 1902 experiments, which resulted in failures, came from vines growing in the open and rooted in clay soil. The idea that pollen coming from the big elm tree vine is in some way peculiarly efficacious in producing seed is confirmed by the fact that a vine within one hundred yards of it, and favorably located to encourage humming-birds to visit between the two, has borne an abundant crop of capsules for the past two years.

The only insects noticed on the trumpet-flowers were robbers, whose visits were without compensating advantages. Black ants and little sweat bees came early and stayed late; the ants to get nectar, and the bees to collect pollen. Sometimes they found an entrance between the lobes of the corolla limb before the flower was open. The bees made short work of collecting all the pollen in sight—half of it going within fifteen minutes. When the pollen was knocked down into the tube they did not seem to be in any way put out, but went on collecting until all was gone. As many as six bees were seen together in a corolla, very busy, crowding and fighting for place. Had they found any pollen on a stigma they would have taken it. During a drouth conical holes were found in the calyx, of many flowers, that reached down to the ovary, and as mud-dauber wasps, *Sphegidæ*, were seen about the holes they were charged with making them. After rain came they disappeared, and may have done the

drilling to get at the nectar as food, or as a substitute for water in tempering their building material. Humble and honey-bees occasionally were seen prospecting around the flowers, but they rarely stopped for more than a moment.

It is remarkable, while the mechanism of *Tecoma* is peculiarly effective in preventing self-pollenation, that its pollen is impotent except when applied to the stigma of another plant under restricted conditions, and that the humming-bird is its only visitor of service in its fertilization.

Impatiens aurea Muhl. The pale touch-me-not is a common plant in Indiana, growing best in the damp, rich soil of the shaded river bottoms.

The mechanism of the flower is generally understood, but the part played by the scales, on the inner side of the filaments, is not so well known. The filaments are so arranged as to form a group, which is held together by the coherent scales. With reference to the mouth of the spur the posterior part of the group is closed by a single filament and the sides by two filaments, leaving the front with a larger opening between the anterior pair than elsewhere. The scale of the posterior filament is divided into two parts which are continuous with the coherent scales of the sides. The two resulting appendages are symmetrical, and are in close contact, on an antero-posterior line, so as to form a roof or hood over the end of the stigma. On the under side of the hood is a pocket into which the stigmatic end of the ovary is inserted. The end of the ovary is marked by a slight papilla near the anterior end of the dividing line of the hood. The pocket is so placed with reference to the plane of the hood that the end of the ovary does not push at right angles, but in an oblique direction. The filaments cease to grow when the flower opens, while the ovary continues to increase in length, and by this arrangement with reference to the hood it pushes against it without protruding, until the filaments are broken from their attachment to the receptacle. When the connection with the receptacle is broken the filaments curl backward with such force as to often cause the cap of withered anthers to fall to the ground. If this does not happen, the cap is easily displaced by the first insect-visitor that attempts to enter the spur.

When it is recalled that the touch-me-not flower is suspended from the end of a slender peduncle, and bobs and swings with every breeze or touch of an insect, the function of the hood in excluding self-pollenation becomes evident. Observations show that the hood is frequently covered with pollen that has sifted through the chink between the anthers, or has

been carried to it by small insects. But the stigmas are not always so well protected as the foregoing might indicate. As the season advances flowers begin to appear in which the stigmatic end of the ovary is exposed. On the 16th of September a patch of *I. aurea* was visited and the ovary found protruding in a majority of those examined. That this change was due to the waning vigor of the plant seems to be shown when, at a later date, after rain and continued warm weather, only one out of twenty-five flowers was found with the stigma exposed. Examination with a microscope showed pollen adhering to the papillæ of the stigma. Soon after the exposed stigmas are seen cleistogamous flowers begin to appear.

Just over, or anterior to the protuberance, made on the hood by the end of the ovary, is an erect, membranous appendage, composed of two pieces about one line long. Its function is not obvious, but it may serve as an increased protection to the stigma against self-pollenation. So far as seen it is peculiar to *Impatiens aurea*.

Impatiens biflora, Walt. After two years of observation, I am led to believe that the spotted touch-me-not produces its crop of cliestogamous flowers in the spring only, before the conspicuous flowers begin to appear. This fact has led some writers, who looked for them in autumn, to state that this species does not produce concealed flowers. Last spring hundreds of them were examined and concealed flowers found in the axils of the leaves of all the plants over six inches high. The glaucous stem of the *I. aurea* distinguishes the young plant of that species before it blooms, but to make sure of the species, they were again visited after conspicuous flowers had become abundant. The first conspicuous flowers had the stigmas exposed through a hole in the hood. But this exposure of the stigma was confined to the spring flowers. The first normal flower seen in my yard came into bloom June the 9th, and produced a seed-bearing capsule. The distance at which this plant grew, from any others then in bloom of the same species, probably excludes the possibility of cross-fertilization. Those blooming a few days later had holes in the hood.

The touch-me-not is cross-fertilized through the agency of bees. Rarely a humming-bird poises over a flower, but does not seem to find anything to detain it long. Its bill is too long and slender to make it a good instrument for carrying pollen. Humble-bees become numerous about the flowers late in the season, and by their size and clumsy move-

ments, not only detach the anther cap, but frequently manage to bring themselves to the ground imprisoned in a withering corolla. Other smaller bees, in search of honey, enter the spur without touching the anthers.

Claytonia Virginica L. The movements of the stamens and stigmas of this plant are curious and somewhat puzzling. When the petals first open the pistil is longer than the proterandrous stamens, but of the same length after the branches of the stigma are recurved. In some flowers the stamens remain clustered around the style and closed stigma for a time after the petals have opened, and while in this position, the under part of an insect-visitor readily becomes dusted with pollen. Later the stamens are bent backward until the anthers rest on the face of the horizontal pistils. When this outward movement of the stamens takes place the lobes of the stigma are also bent outward and in position for cross-fertilization. Quite often it happens that it can scarcely be said that the stamens are proterandrous, all the movements before described occurring at the time the anthers become dehiscent. When this takes place the insect-visitor has little chance of collecting pollen, but it leaves the stigma in an ideal position for cross-fertilization. Flowers can be found in all of these stages at the same time; and the honey-bee in making its rounds soon becomes dusted with pollen, without having to depend on the recurved stamens for a supply.

Unlike many flowers that are in part or wholly dependent on insects for fertilization, the spring beauty lasts but one day. It comes into bloom early in the season and its day is past before insects become numerous, hence, as might be expected, there is a provision which assures self-pollenation. The petals that open in the morning begin to close in the afternoon, and by night are gathered into an imbricated roll. If the day has been cold and the lobes of the stigma have not become fully recurved, so as to bring their papillæ on a level with the anthers, the process of recurvation is completed before they are caught by the closing petals. Examination shows that after closing the anthers with pollen still adhering are in close contact with the stigma. Pollen was found at night on the papillæ of the old flowers that was not there before insects ceased to fly that afternoon. No insect other than the honey-bee was seen about them, and, as its visits were rather rare, the numerous and well filled capsules must have been the result of self-pollenation.

Hydrophylum appendiculum Michx. is proterandrous. When the flower first comes into bloom the pistil is about one-half the length of the mature stamens. The dehiscing anthers are gray with pollen, which disappears within six hours. By the time the pollen is gone the pistil has grown to the same length as the stamens, the two lobes of the stigma are recurved and ready for cross-pollenation. Bees are the pollen carriers, which they get from the anthers of flowers that bloom at irregular hours throughout the day. A plant in my yard began to bloom early in May and was still producing a few flowers August 8th. During dry weather in July, the flowers were less than one-half the normal size, the tube very much shortened, and in others the corolla changed from campanulate to rotate.

Polemonium reptans L. The stamens are uot as long as the pistil. Dehiscence begins when the corolla is about half open, and before the lobes of the stigma are recurved. Later the stamens are bent outward and the pistils left to occupy the center field. Honey-bees enter the half-blown flowers and come out well dusted with pollen, which they carry to the older flowers. Invariably, when a bee comes to a plant, it pays its respects first to the half-blown flower, and may not visit the older ones at all. It seems to know that they have been exhausted of nectar. As it enters the slenderly supported flower it clasps all the organs at once, and its movements are about as graceful as those of the humble-bee.

The pistil of *Lysimachia quadrifolia* L. and of *L. terrestris* (L.) B. S. P. when the flowers first open are sharply curved to one side by a bend near the middle of the style. After the anthers have shed their pollen the pistil is erected and the stigma in position for cross-fertilization by the insect-visitor. That this may be accomplished, the blooms last for several days.

The stigmatic lobes of *Sabbatia angularis* (L.) *Pursh.* are as long or longer than the supporting style and the whole pistil only about one half the length of the stamens when the flower first opens. To make it doubly sure that self-pollenation shall not occur, the lobes are closely twisted together until the coiled anthers have unrolled and shed their pollen. In the meantime the pistil has increased in length and the lobes curved back at right angles to the style. The lobes are stigmatic along the inner side, and remained twisted after they are recurved, so that an insect passing over or under them with pollen on its back or under parts, would be likely to effect fertilization. Many of the flowers are in bloom

at the same time, are quite handsome, fragrant, and stay in bloom a week or more. It is curious that finding the plant in a certain locality one season is no sign that it can be found there next year.

Taraxacum Taraxacum (L.) Kerst. While watching the effects of temperature on the dandelion in June a number were found which were not producing pollen, the heads were perfect in every way, but had no pollen on the styles or branches of the stigmas when the bees were excluded.

The connate anther-tubes, which were of the normal form in all stages of development, were examined under the microscope and not a grain of pollen found in them. The sterile heads were of a uniform pale yellow and lacked the golden tinted center of the fertile heads found growing near by. Bees indifferently passed from one kind to the other. Seed was formed on the sterile heads, but there were more aborted achenes than usual.

The dandelion is very sensitive to change of temperature, while the absence of sunshine has very little effect. Early in the season the same heads may be exposed as often as three days in succession, and the involucre not be opened for more than two or three hours at any one time. As the temperature increases they stay exposed from early morning until shut up by the falling temperature of the afternoon, and may not open again next day.

Ruellia strepens L. produces a large crop of cleistogamous flowers during late summer and autumn. The flowers are clustered in the axils and hidden by the long segments of the calyx. The change from conspicuous to concealed flowers involves more than a change from gamopetalous to apetalous. The stamens are reduced in length to that of the ovary with a small pollen-producing surface at the tip, which is in close proximity to the sessile stigma. The resulting capsules are numerous and well filled with seed.

Falcata comosa (L.) Kuntze sends forth long, slender, stoloniferous runners in early summer that produce apetalous flowers before the conspicuous blooms appear. Not only is the form of the flower quite different from that of those coming later, but the early, ovoid, single-seeded, fleshy pod is very unlike the three-seeded, bean-like pod of the later flowers. The mature single-seeded pods are found on or near the ground after the conspicuous flowers have come into bloom.

If *Oxalis stricta* L. produces cleistogamous flowers on recurved scapes, at the base of the plant I have not seen them, but have found flowers in

July in which the calyx remained closed over the dwarfed corolla. The only change in structure noted was that the five shorter stamens bore aborted anthers, and that the pollen-bearing anthers were in contact with the stigma. Contrary to what some writers state the stamens of *O. Stricta* are often dinorphic. The self-pollenation of the normal flower is accomplished by the corolla closing after exposure, and pressing the anthers against the stigma.

One of the most interesting changes in structure from a conspicuous to a cleistogamous flower is seen in the violet. The showy flowers are so constructed that the honey-bee is the only insect that I know to be of service in its fertilization, and only a part of the anthers are called into use by it. To reach the spur in which the nectar is stored, the bee, after it settles, has to reverse its position, and force its tongue between the two appendages on the lower stamens. In doing this it comes in contact with the stigma and at the same time is dusted with pollen from the appendaged stamens. The anthers of the other three stamens do not aid in supplying the bee with pollen, and seem to be of very little if any use to the plant. In the concealed flowers, they are aborted. The pistil, of the cleistogamous flowers of *Viola Striata* Ait., is declined, so as to bring the stigma against the end of the ovary, and in contact with the two connivent anthers. Two appendages grow from the fertile stamens, just below the anthers, that are expanded so as to cover the anthers and the whole of the pistil.

V. striata continues to produce showy flowers longer than many other species, and as a consequence its concealed flowers come in summer.

Viola pubescens Ait. develops a few yellow flowers in early spring. It continues to grow until August, and as it grows, concealed flowers are developed in the axils of the leaves.

The abruptness of the change from a showy to a cleistogamous flower was beautifully shown on a plant of *Impatiens biflora* that produced a well-developed, conspicuous flower on one branch of a peduncle and a concealed flower on the other branch.

The fact that the stigma of *Tecoma radicans* returns to its former position in two hours after it has been changed in response to an irritant, unless the irritation has been accomplished by pollen of a certain quality, shows that the process of fertilization begins within two hours after the right kind of pollen has been applied, and that the stigma is endowed with remarkable selective power. The whole process suggests the shad-

owy beginning that has culminated in the will, and recalls Professor Minot's definition of consciousness, "the function of consciousness is to dislocate in time the reactions from sensations." In *Tecoma* the reaction is not dislocated from the sensation, for there can not be such a thing as sensation in a plant, but there is a curious tendency in that direction.

The calyx of *Scutellaria cordifolia* Muhl. splits back to the base at maturity, and the helmet-like upper lip falls away. Before the upper lip falls the ripe nutlets lie loose in the bowls of the persistent lower lip. A gust of wind strong enough to set the dry leafless stems to swaying will detach the upper lip and send the seeds flying with the wind.

The following plants, which are not included in Professor Coulter's "Flowering Plants and Ferns of Indiana," are known to occur in Bartholomew County. *Quercus Schneckii* Britton is common in the western part of the county, and frequently wherever red and black oaks grow. *Quercus Alexanderi* Britton formerly was abundant on the Knobstone hills of Bartholomew and Brown counties and the north part of Jackson County. Locally it is known as chestnut oak or tan-bark oak. Some years ago the bark was an important source of revenue to the inhabitants of Brown County. Along the line of the Baltimore & Ohio Southwestern Railroad, where it grows in dense forests, it is being shipped for use as telephone poles.

Perilla frutescens (L.) Britton grows on the south side of Columbus, Hope & Greensburg Railroad one-fourth mile east of Lambert's Switch. It is abundant in that locality.

Tradescantia bracteata Small occurs sparingly, and *T. reflexa* Raf., commonly, on the sandhills of Bartholomew and Brown counties. *T. bracteata* blooms in April, and does not last later than May. The oaks above named have been reported as occurring in the State by Professor Coulter, the others are believed to be new to the Indiana list.

Bird Notes From the Indiana State Forestry Reservation.

By Chas. Piper Smith.

During the summer of 1903 I was fortunate in being located, for some five weeks, upon the State Forestry Reservation, in the "Knob" region of southern Indiana. Although engaged in making a survey of the plant life of the Reservation, my ears were ever attentive to the bird voices about me, and a list of the various species heard or seen was preserved. Sixty-one species were noted within Reservation limits, as recorded below. No especial care was taken to study the relations of the birds to the trees and their other natural surroundings; but a few general remarks may be based upon a review of the bare list.

It will be noticed that the birds enumerated include forms characteristic of both woodland and open, though the number of woodland species far exceeds the number of kinds loving the field, sky or orchard. The absence of running water, during the summer and fall months, makes impossible the conditions necessary to attract water and swamp-loving forms; hence the scarcity of such in the list. Of the two thousand acres composing the Reservation, possibly eighteen hundred are wooded. Thus it is apparent why the woodland birds exceed in number of species; and it is likewise true that many of these woodland forms lead in regard to number of individuals. Some four hundred feet difference in elevation exists between the lowlands and the tops of the higher knobs, the deep ravines between the knobs forming tempting bird haunts.

Although not intending to give time to my favorite study, the birds and all that concerns them, I was ready to give heed to Mr. Butler's suggestion to look for the Pine Warbler, *Dendroica vigorsii*, and evidence of its nesting there. As far as known to us, this bird has not been definitely reported as a breeder within our State, although there are several localities which have conditions apparently meeting the demands of this pine-loving little warbler. What evidence I was able to glean is contained in the following testimony, but it is, of course, not equal to the best evidence, namely, the collection of a nest with the eggs and the parents.

I first saw the Reservation on the twentieth of July and I began my

list that day. Two days later, while upon the Hollister knob, an unfamiliar bird song diverted my attention from stuffing plants and leaves into my "botany-can," and, forgetting my botanical work for a few moments, I turned aside to seek the singer. The song ceased upon my intrusion, but after a short search, I spied a family of four small dull-colored warblers which seemed not anxious to make my acquaintance. As I had no means of getting one of these into my hand, I was about to pass the group by as too uncertain of identification for recording, when a male Pine Warbler, as easily recognized, joined them and showed himself to be no stranger amongst them. Then resemblances in plumage were noted which removed all doubt on my part as to the identity of the others. Three of the family, in appearance and voice, strongly suggested young of the year, and, before I left them, or rather they left me, I had the pleasure and satisfaction of seeing the supposed female side up to and feed one of the three of juvenile appearance.

Later this song was heard on various occasions, and, on July 21st and August 18th, I had most satisfactory observation of Pine Warblers, both of adult males and their duller-colored followers; but no further evidence was secured as to the breeding of this species there. All my Pine Warbler observations were upon the knob-tops, close to the pine areas. I am anxious to visit the Reservation during some May or June when, I am confident, I could collect more conclusive evidence of the breeding of the Pine Warbler within our State.

As to the other Reservation birds I will limit myself to the mere listing of them, the species recognized being:

1. *Colinus virginianus* (Linn.). Bob-white.
2. *Zenaidura macroura* (Linn.). Mourning Dove.
3. *Cathartes aura* (Linn.). Turkey Vulture.
4. *Falco sparverius* Linn. American Sparrow Hawk.
5. *Megascops asio* (Linn.). Screech Owl.
6. *Coccyzus americanus* (Linn.). Yellow-billed Cuckoo.
7. *Dryobates villosus* (Linn.). Hairy Woodpecker.
8. *Dryobates pubescens medianus* (Swains.). Downy Woodpecker.
9. *Melanerpes erythrocephalus* (Linn.). Red-headed Woodpecker.
10. *Colaptes auratus luteus* Bangs. Northern Flicker.
11. *Antrostomus vociferus* (Wils.). Whip-poor-will.
12. *Chordeiles virginianus* (Gmel.). Nighthawk.

13. *Chætura pelagica* (Linn.). Chimney Swift.
14. *Trochilus colubris* Linn. Ruby-throated Hummingbird.
15. *Tyrannus tyrannus* (Linn.). Kingbird.
16. *Myiarchus crinitus* (Linn.). Crested Flycatcher.
17. *Sayornis phœbe* (Lath.). Phœbe.
18. *Contopus virens* (Linn.). Wood Pewee.
19. *Empidonax virescens* (Vieill.). Green-crested Flycatcher.
20. *Cyanocitta cristata* (Linn.). Blue Jay.
21. *Corvus americanus* Aud. American Crow.
22. *Molothrus ater* (Bodd.) Cowbird.
23. *Sturnella magna* (Linn.). Meadowlark.
24. *Icterus galbula* (Linn.). Baltimore Oriole.
25. *Astragalinus tristis* (Linn.). American Goldfinch.
26. *Poœcetes gramineus* (Gmel.). Vesper Sparrow.
27. *Coturniculus savannarum passerinus* (Wils.). Grasshopper Sparrow.
28. *Chondestes grammacus* (Say). Lark Sparrow.
29. *Spizella socialis* (Wils.). Chipping Sparrow.
30. *Spizella pusilla* (Wils.). Field Sparrow.
31. *Peucæa æstivalis bachmanii* (Aud.). Bachman Sparrow.
32. *Pipilo erythrophthalmus* (Linn.). Towhee.
33. *Cardinalis cardinalis* (Linn.). Cardinal.
34. *Cyanospiza cyanea* (Linn.). Indigo Bunting.
35. *Piranga erythromelas* Vieill. Scarlet Tanager.
36. *Piranga rubra* (Linn.). Rose Tanager.
37. *Progne subis* (Linn.). Purple Martin.
38. *Hirundo erythrogaster* Bodd. Barn Swallow.
39. *Ampelis cedrorum* (Vieill.). Cedar Waxwing.
40. *Lanius ludovicianus* Linn. Loggerhead Shrike.
41. *Vireo olivaceus* (Linn.). Red-eyed Vireo.
42. *Vireo gilvus* (Vieill.). Warbling Vireo.
43. *Mniotilta varia* (Linn.). Black and White Warbler.
44. *Helminthophila pinus* (Linn.). Blue-winged Warbler.
45. *Dendroica vigorsii* (Aud.). Pine Warbler.
46. *Seiurus aurocapillus* (Linn.). Oven-bird.
47. *Geothlypis formosa* (Wils.). Kentucky Warbler.
48. *Geothlypis trichas* (Linn.). Maryland Yellow-throat.
49. *Icteria virens* (Linn.). Yellow-breasted Chat.
50. *Wilsonia mitrata* (Gmel.). Hooded Warbler.

51. *Galeoscoptes carolinensis* (Linn.). Catbird.
52. *Toxostoma rufum* (Linn.). Thrasher.
53. *Thryothorus ludovicianus* (Lath.). Carolina Wren.
54. *Thryomanes bewickii* (Aud.). Bewick Wren.
55. *Sitta carolinensis* Lath. White-breasted Nuthatch.
56. *Baeolophus bicolor* (Linn.). Tufted Titmouse.
57. *Parus carolinensis* Aud. Carolina Chickadee.
58. *Polioptila caerulea* (Linn.). Blue-gray Gnatcatcher.
59. *Hylocichla mustelina* (Gmel.). Wood Thrush.
60. *Merula migratoria* (Linn.). American Robin.
61. *Sialia sialis* (Linn.). Bluebird.

Notes Upon Some Little-Known Members of the Indiana Flora.

By Chas. Piper Smith.

As a member of the senior class in botany at Purdue, during the last spring, I began a season of active field work in botany, which circumstances led me to continue through the summer and autumn.

Five weeks during July and August were spent upon the State Forestry Reservation, in Clark County, the major portion of the season, however, after leaving Lafayette in June being spent about Indianapolis.

Britton and Brown's "Illustrated Flora of the Northern States and Canada" was used as the basis of study, the more recent Britton's Manual not being at hand for comparison.

Dr. Coulter's catalogue of the State flora was always referred to as each plant was handled, and it is in reference to this list that I make the following notes.

Most of the plants here considered have been checked over for me by Mr. Bartlett, of the Shortridge High School, and most of the specimens upon which determinations have been based have been laid before Dr. Stanley Coulter and left in his charge.

Carex Baileyi Britton. Bailey's Sedge.

Common about Indianapolis. Taken by Mr. Bartlett and myself along streams and in wet places. Also taken by me upon the Forestry Reservation, where it was first recognized. Not recorded by Dr. Coulter.

Carex Hitchcockiana Dewey. Hitchcock's Sedge.

Taken by me in Tippecanoe County. Noted but once.

Carex Careyana Torr. Carey's Sedge.

Found once in Marion County.

Carex stipata Muhl. Awl-fruited Sedge.

Taken in Tippecanoe County.

Carex vulpinoidea Michx. Fox Sedge.

Taken in Hamilton County.

Carex sterilis Willd. Little Prickly Sedge.

Taken in Tippecanoe County.

Carex Muskingumensis Schwein. Muskingum Sedge.

Taken in Hamilton County, associated with the next.

Carex scoparia Schk. Pointed Broom Sedge.

Carex cristatella Britton. Crested Sedge.

Common in Hamilton and Marion counties. Heretofore unrecorded.

Juncus marginatus aristulatus (Michx.) Coville.

This form of the Grass-leaved Rush was found upon the Reservation. Not reported in the State catalogue.

Quercus Prinus L. Rock Chestnut Oak.

This species is the chestnut oak of the Forestry Reservation. As Dr. Coulter withdraws the record for Tippecanoe County, this form is not definitely recorded from the State, though I am sure that others have recognized it. I have studied the specimens of *Q. Alexandrii* near Lafayette, as also various specimens of *Alexandrii* and *acuminata* about Indianapolis, and I am sure that the Reservation chestnut oaks should be referred to this species.

Sisymbrium altissimum L. Tall Sisymbrium.

Taken by Mr. Benj. W. Douglass and myself along the "Menon," north of the State Fair Grounds, Indianapolis. One fine, large specimen was the only one found.

Agrimonia pumila Muhl. Small-fruited Agrimony.

Taken upon the Reservation. Not very common. Found with *A. mollis*, which was quite common.

Vicia angustifolia Roth. Smaller Common Vetch.

Taken by Mr. Harley, H. Bartlett and myself along the "Monon," north of the State Fair Grounds, Indianapolis.

Hypericum maculatum Walt. Spotted St. John's-wort.

Reported from only one county (Steuben), but frequent in Marion County, and abundant upon the Reservation. *H. perforatum* was also taken in Marion County, and was used for comparative study.

Sarothra gentianoides L. Pine-weed.

Presumably one of the rarest plants of the State. A small patch of plants was found upon the Reservation.

Lechea racemulosa Michx. Oblong-fruited Pin-weed.

Lechea tenuifolia Michx. Narrow-leaved Pin-weed.

These two pin-weeds are common in certain dry, barren areas on the Reservation, and are always associated where found. *L. racemulosa* has not been recorded from the State.

Angelica villosa (Walt.) B. S. P. Pubescent Angelica.

A common plant on the Reservation. An addition to the State flora.

Scutellaria campestris Britton. Prairie Skullcap.

Noted as common on one barren knob-side upon the Reservation. First record for the State. *S. parvula* was also taken, in moist soil in the lowlands. The hairy form seems to be well defined.

Stachys ambigua (A. Gray) Britton. Dense-flowered Hedge Nettle.

Taken upon the Reservation. First record for the State.

Salvia lanceolata Willd. Lance-leaved Sage.

Found sparingly at a dumping ground along Fall Creek, at Central Avenue, Indianapolis. Identification verified by Prof. W. S. Blatchley. Second Indiana station of this western plant.

Ilysanthes attenuata (Muhl) Small. Short-stalked False Pimpernel.

This easily recognized form was taken upon the Reservation. First record for the State.

The Development of the Spermatozoid of Chara.

By D. M. Mottier.

(Abstract.)

The spermatozoid of *Chara fragilis* is a spirally-coiled body consisting of a nucleus and a specially differentiated part of the cytoplasm, the blepharoplast, existing in the form of a thread, or band, bearing two long cilia. The nucleus occupies the middle part of the spermatozoid. The anterior end of the blepharoplast is thinner than the posterior and tapers slightly toward the extremity. The two cilia are borne some distance back of the anterior extremity. The posterior end is broader and thicker and terminates bluntly. In cross section the blepharoplast is crescentic, being convex on the outside and concave within. With the exception of a strip of granular substance along the concave side of the posterior end, it is of a homogeneous structure. The entire spermatozoid makes two and one-half or three spiral turns.

The blepharoplast arises as a delicate thread-like differentiation of the cytoplasm at the surface of the cell, extending some distance along the cell from the nucleus and on opposite sides of the latter. It seems to be a modification of the plasma membrane. No centrosome-like body, or "Plasmahöcker," was observed from which the blepharoplast might develop as described by Belajeff, Strasburger and others.

The nucleus is transformed from an elliptical or oval body, with a hollow chromatin spirem, to a dense, homogeneous, sausage-shaped structure making one spiral turn or more.

The cilia were always found attached some distance back of the anterior extremity of the blepharoplast. Their origin was not traced to a centrosome-like body, but they seemed to grow directly from the thread-like blepharoplast.

Contribution to the Flora of Indiana.

By Stanley Coulter.

(By title.)

Further Studies on Anomalous Dicotyledonous Plants.

By D. M. Mottier.

(Abstract.)

The studies referred to deal with the development of the embryo with special reference to the origin of the cotyledons in *Actea alba*, *Stylophorum diphyllum* and *Sanguinaria canadensis*. In the origin of the cotyledons all three species show, in varying degrees, the distinguishing characteristics of typical anomalous dicots. In each the embryo becomes pear-shaped before any indication of the cotyledonar primordium is apparent. The primordium of the cotyledons now appears as an almost complete, circular, ridge-like outgrowth from the margin of the broadly truncated end of the embryo. With the further growth of this ridge a bifurcation soon appears at a point exactly opposite the primary cleft of the primordium, so that the two young cotyledons, which may or may not be of the same size, seem to represent two separate and opposite lobes of the distal end of the embryo with one of the clefts a little deeper than the other. In some cases (Stylophorum) the two cotyledons seem to arise as separate and independent outgrowths, but a little later their common base grows faster on one side than on the other, and in this manner the two clefts or bifurcations become unequal in depth.

It is important to note, however, that in embryos of different individuals of the same species the anomalous character is much more strongly marked than in others.

On the Germination of Certain Native Weeds.

By Stanley Coulter.

(By title.)

Revised List of Indiana Plant Rusts.

By J. C. Arthur.

Five years ago a list of the plant rusts of Indiana was prepared, and printed in the Proceedings for 1898, to show not only how many and what species occur within the State, but the application of the revised nomenclature, to which great attention has been directed within the last decade. At that time the writer had made little study of the basis for the generic names, but accepted largely the conclusions announced by Kuntze in his *Revisio generum plantarum*. Since the presentation of the list, two other papers have been brought before the Academy by the writer, discussing the status of the genus names *Puccinia* and *Gymnosporangium*, the only considerable points in controversy touched by the Indiana list.

In order to embody the latest conclusions and reaffirm those remaining unchanged, as well as to correct a few errors and add the species brought to light since that list was issued, the writer presents herewith a revised list of the Indiana plant rusts. It is given in the latest nomenclature to familiarize the members of the Academy with this phase of scientific movement. It is not a nomenclature that can be generally used at present, for the reason that no standard works of reference are yet available employing the accepted names. But it does not materially detract from the usefulness of a local list, like the present one, and yet gives the reader a chance to see the direction in which the new movement is leading.

The present list, like the preceding one, does not include the unattached aecidia and uredo. Some thirteen of these that have been mentioned from time to time in the Proceedings of the Academy have been traced to their teleutosporic connections since the last revised list was published, and are here included as autonomous species. Besides these, eleven species of rusts have been added to the State flora, having never been reported in any form before. The hosts reported in this list for the first time are recorded by month, county and collector. The specimens, on which these data are based, are in the herbarium at Purdue University. The references after the other hosts are to the page and

year of the Proceedings of the Academy, where additional information can be found. The nomenclature for hosts is that of Britton and Brown's "Illustrated Flora of the Northern States and Canada."

The present list contains 105 species of plant rusts under sixteen genera, being an increase of more than 33 per cent. over the previous list of 1898, which contained 80 species under ten genera.

COLEOSPORIACEÆ.

1. COLEOSPORIUM SONCHI-ARVENSIS (*Pers.*) *Wint.*
   On Hieracium scabrum Michx. Vigo Co., 5, 1893 (Underwood).
2. COLEOSPORIUM IPOMŒÆ (*Schw.*) *Bur.*
   On Ipomœa pandurata (L.) Mey. 1896:171, 218.
3. COLEOSPORIUM SOLIDAGINIS (*Schw.*) *Thuem.*
   On Aster azureus Lindl. 1893:50.
   On Aster cordifolius L. 1893:51.
   On Aster Novæ Angliæ L. 1893:51.
   On Aster paniculatus Lam. 1893:51.
   On Aster puniceus L. 1893:51.
   On Aster sagittifolius Willd. 1893:51.
   On Aster salicifolius Lam. 1893:51.
   On Aster Shortii Hook. 1893:51.
   On Aster Tradescanti L. 1893:51.
   On Solidago arguta Ait. 1893:51.
   On Solidago cæsia L. 1893:51.
   On Solidago Canadensis L. 1893:51.
   On Solidago flexicaulis L. (*S. latifolia* L.) 1893:51.
   On Solidago patula Muhl. 1893:51.
   On Solidago rugosa Mill. 1893:51.
   On Solidago serotina Ait. 1893:51.
4. COLEOSPORIUM VERNONIÆ *B. & C.*
   On Vernonia fasciculata Michx. 1893:51.
   On Vernonia Noveboracensis (L.) Willd. 1893:51.

MELAMPSORACEÆ.

5. CHRYSOMYXA ALBIDA *Kühn.* (*Coleosporium Rubi E. & H.*)
   On Rubus cuneifolius Pursh. 1893:50.
   On Rubus villosus Ait. 1893:50.

6. PUCCINIASTRUM AGRIMONIÆ (*DC.*) *Diet.* (*Uredo Agrimoniæ* Schw.)
   On Agrimonia hirsuta (Muhl.) Bick. (*A. Eupatoria* Am. Auct.) 1893:50. 1896:218.
   On Agrimonia parviflora Sol. 1893:50.
7. THECOPSORA HYDRANGEÆ (*B. & C.*) *Magn.* (*Uredo Hydrangeæ* B. & C.)
   On Hydrangea arborescens L. 1893:56. 1896:218.
8. HYALOPSORA POLYPODII (*Pers.*) *Magn.* (*Uredo Polypodii* DC.)
   On Cystopus fragilis (L.) Bernh. 1893:56.
9. MELAMPSORA MEDUSÆ *Thuem.*
   On Populus balsamifera L. 1893:51.
   On Populus deltoides Marsh. (*P. monilifera* Ait.) 1893:51. 1896:218.
   On Populus grandidentata Michx. 1893:51.
   On Populus tremuloides Michx. 1893:51. 1898:188.
10. MELAMPSORA FARINOSA (*Pers.*) *Schræt.*
   On Salix amygdaloides Anders. Steuben Co., 8, 1903 (*Kellerman*).
   On Salix cordata Muhl. 1893:51.
   On Salix discolor Muhl. 1893:51. 1896:218.
   On Salix fluviatilis Nutt. (*S. longifolia* Muhl.) 1893:52.
   On Salix interior Rowl. Steuben Co., 8, 1903 (*Kellerman*).
   On Salix nigra Marsh. 1893:51.
11. MELAMPSORIDIUM BETULINUM (*Pers.*) *Kleb.*
   On Betula lutea Michx. Steuben Co., 8, 1903 (*Kellerman*).

PUCCINIACEÆ.

12. AREGMA DISCIFLORA (*Tode*) *Arth.* (*Phragmidium subcorticium* Wint.)
   On Rosa Carolina L. 1893:52.
   On Rosa humilis Marsh. (*R. lucida* Am. Auct.) 1893:52.
   On Rosa setigera Michx. 1893:52.
13. AREGMA FRAGARLIÆ (*DC.*) *Arth.*
   On Potentilla Canadensis L. 1893:52. 1896:218.
14. AREGMA SPECIOSA *Fr.* (*Phragmidium speciosum* Cke.)
   On Rosa Carolina L. 1896:219.
   On Rosa humilis Marsh. 1898:179.
15. TRIPHRAGMIUM ULMARIÆ (*Schum.*) *Lk.*
   On Ulmaria rubra Hill. Tippecanoe Co., 6, 1899 (*Arthur*).

16. GYMNOCONIA INTERSTITIALIS (*Schl.*) *Lagh.* (*Puccinia Peckiana* Howe and *Æcidium nitens* Schw.)
    On Rubus occidentalis L. 1893:54.
    On Rubus villosus Ait. 1893:54. 1896:220. 1898:188.

17. CÆOMURUS ACUMINATUS (*Arth.*) *Kuntze.*
    On Spartina cynosuroides Willd. Jasper Co., 5, 1903 (*Arthur*); Steuben Co., 8, 1903 (*Kellerman*).

18. CÆOMURUS CALADII (*Schw.*) *Kuntze.* (*Uromyces Caladii* Farl.)
    On Arisæma triphyllum (L.) Torr. 1893:56. 1896:222. 1898:189.
    On Arisæma Dracontium (L.) Schott. 1893:56. 1896:222.

19. CÆOMURUS CARYOPHYLLINUS (*Schr.*) *Kuntze.*
    On Dianthus Caryophyllus L. 1893:56.

20. CÆOMURUS EUPHORBIÆ (*Schw.*) *Kuntze.*
    On Euphorbia dentata Michx. 1893:57. 1896:222.
    On Euphorbia nutans Lag. (*E. hypericifolia* Gr.) 1893:57. 1896:222.
    On Euphorbia humistrata Engelm. Tippecanoe Co., 6, 1902 (*Arthur*).

21. CÆOMURUS SOLIDAGINI-CARICIS (*Arth.*) *nom. nov.*
    On Carex lanuginosa Michx. Jasper Co., 3, 1903 (*Arthur*).
    On Carex varia Muhl. Jasper Co., 3, 1903 (*Arthur*).

22. CÆOMURUS GRAMINICOLUS (*Barr.*) *Kuntze.*
    On Panicum virgatum L. 1893:57.

23. CÆOMURUS HOWEI (*Pk.*) *Kuntze.*
    On Asclepias incarnata L. 1893:57. 1896:222.
    On Asclepias purpurascens L. 1893:57.
    On Asclepias Syriaca L. (*A. Cornuti* Dec.) 1893:57. 1896:222. 1898:187.

24. CÆOMURUS HEDYSARI-PANICULATI (*Schw.*) *Arth.*
    On Meibomia Canadensis (L.) Kuntze (*Desmodium C.*). 1896:222.
    On Meibomia canescens (L.) Kuntze (*Desmodium c.*). 1893:57.
    On Meibomia Dillenii (Darl.) Kuntze (*Desmodium D.*). 1893:57. 1896:222.
    On Meibomia lævigata (Nutt.) Kuntze (*Desmodium l.*). 1893:57.
    On Meibomia paniculata (L.) Kuntze (*Desmodium p.*). 1893:57.
    On Meibomia viridiflora (L.) Kuntze (*Desmodium v.*). 1893:57.

25. CÆOMURUS HYPERICI-FRONDOSI (*Schw.*) *Arth.*

On Hypericum Canadense L. 1893:57.

On Hypericum mutilum L. 1893:57.

On Triadenum Virginicum (L.) Raf. (*Elodea campanulata* Marsh.) 1893:57.

26. CÆOMURUS JUNCI (*Schw.*) *Kuntze.*

On Juncus tenuis Willd. 1896:222. 1898:187.

27. CÆOMURUS LESPEDEZÆ-PROCUMBENTIS (*Schw.*) *Arth.*

On Lespedeza frutescens (L.) Brit. (*L. reticulata* Pers.) 1893:57.

On Lespedeza procumbens Michx. 1893:57.

On Lespedeza repens (L.) Bart. 1896:222.

On Lespedeza capitata Michx. Jasper Co., 3, 1903 (*Arthur*).

On Lespedeza hirta (L.) Ell. Marshall Co., 10, 1893 (*Underwood*).

28. CÆOMURUS OROBI (*Pers.*) *nom. nov.*

On Vicia Americana Muhl. 1896:222.

29. CÆOMURUS PERIGYNIUS (*Halst.*) *Kuntze.*

On Carex virescens Muhl. 1893:57.

30. CÆOMURUS PHASEOLI (*Pers.*) *Arth.*

On Strophostyles helvola (L) Brit. (*Phaseolus diversifolius* Pers.) 1893:56. 1896:172, 222.

On Vigna Sinensis (L.) Endl. Tippecanoe Co., 10, 1903 (*Arthur*).

31. CÆOMURUS PLUMBARIUS (*Pk.*) *Kuntze.* (*Uredo gaurina* (Pk.) DeT.)

On Gaura biennis L. 1896:222.

32. CÆOMURUS POLYGONI (*Pers.*) *Kuntze.*

On Polygonum aviculare L. 1893:57. 1896:223.

On Polygonum erectum L. 1893:58.

33. CÆOMURUS RUDBECKIÆ (*Arth. & Holw.*) *Kuntze.*

On Rudbeckia laciniata L. 1894:152. 1898:187.

34. CÆOMURUS TRIFOLII (*Hedw.*) *Gray.*

On Trifolium hybridum L. 1893:58.

On Trifolium medium L. 1893:58.

On Trifolium pratense L. 1893:58. 1896:223. 1898:187, 189.

On Trifolium repens L. 1893:58.

35. CÆOMURUS RHYNCOSPORÆ (*E. & G.*) *Kuntze.*

On Rhyncospora alba Vahl. Tippecanoe Co., 10, 1894 (*King*).

36. DICÆOMA ALBIPERIDIUM (*Arth.*) *nom. nov.*

On Carex pubescens Muhl. Tippecanoe Co., 4, 1901 (*Arthur*).

37. DICÆOMA Aletridis (*B. & C.*) *Kuntze.*
On Aletris farinosa L. Lake Co., 7, 1884 (*Hill*).

38. DICÆOMA AMBIGUA (*J. & S.*) *Kuntze.*
On Galium Aparine L. 1896:172.

39. DICÆOMA ANDROPOGONIS (*Schw.*) *Kuntze.* (*Puccinia Andropogi* Schw.)
On Andropogon furcatus Muhl. 1896:219.
On Andropogon scoparius Michx. 1896:219.
On Pentstemon hirsutus (L.) Willd. 1896:217.

40. DICÆOMA ANEMONES-VIRGINIANÆ (*Schw.*) *Arth.* (*Puccinia solida* Schw.)
On Anemone cylindrica Gr. 1896:219.
On Anemone Virginiana L. Tippecanoe Co., 6, 1903 (*Arthur*); Steuben Co., 8, 1903 (*Kellerman*).

41. DICÆOMA ANGUSTATUM (*Pk.*) *Kuntze.*
On Eriophorum polystachyon L. Noble Co., 8, 1884 (*Van Gorder*).
On Eriophorum Virginicum L. Noble Co., 8, 1884 (*Van Gorder*).
On Scirpus atrovirens Muhl. 1893:52. 1896:219.
On Scirpus cyperinus (L.) Kunth. 1893:52.
On Lycopus Americanus Muhl. (*L. sinuatus* Ell.) 1898:189.

42. DICÆOMA APOCRYPTUM (*E. & Tr.*) *Kuntze.*
On Hystrix Hystrix (L.) Millsp. 1893:52.

43. DICÆOMA ARGENTATUM (*Schultz*) *Kuntze.*
On Impatiens biflora Walt. (*L. fulva* Nutt.) 1893:52. 1896:220.

44. DICÆOMA ASPARAGI (*DC.*) *Kuntze.*
On Asparagus officinalis L. Lake Co., 10, 1899 (*Breyfogle*); Fountain Co., 9, 1900 (*Beatty*); Tippecanoe Co., 3, 1901 (*Arthur*); Steuben Co., 8, 1903 (*Kellerman*).

45. DICÆOMA ASPERIFOLII (*Pers.*) *Kuntze.* (*Puccinia Rubigo-vera* (DC.) Wint.)
On Avena sativa L. 1893:55.
On Secale cereale L. 1896:221.

46. DICÆOMA ASTERIS (*Duby*) *Kuntze.*
On Aster cordifolius L. 1893:52.
On Aster lateriflorus (L.) Brit. (*A. diffusus* Ait.) 1896:219.
On Aster paniculatus Lam. 1893:52.

47. DICÆOMA CANALICULATA (*Schw.*) *Kuntze*. (*Puccinia nigrorelata* E. & T. and *P. indusiata* D. & H.)
On Cyperus strigosus L. 1893:53, 54. 1894:154, 157. 1896:219, 220.

48. DICÆOMA CARICIS-ASTERIS (*Arth.*) *nom. nov.*
On Aster cordifolius L. 1893:49.
On Aster Drummondii Lindl. Tippecanoe Co., 5, 1901 (*Arthur*).
On Aster paniculatus Lam. Tippecanoe Co., 5, 1901 (*Arthur*).
On Aster sagittifolius Willd. 1893:49.
On Carex cephalophora Muhl. Tippecanoe Co., 6, 1902 (*Arthur*).
On Carex fœnia Willd. Tippecanoe Co., 4, 1901 (*Arthur*).

49. DICÆOMA CARICIS-ERIGERONTIS (*Arth.*) *nom. nov.*
On Erigeron annuus L. 1894:151.
On Erigeron ramosus (Walt.) B. S. P. Jasper Co., 6, 1903 (*Arthur*).
On Leptilon Canadense (L.) Britt. Jasper Co., 6, 1903 (*Arthur*).
On Carex festucacea Willd. Tippecanoe Co., 4, 1901 (*Arthur*).
On Carex straminea Willd. 1893:52.

50. DICÆOMA CARICIS-SOLIDAGINIS (*Arth.*) *nom. nov.*
On Solidago cæsia L. 1893:49.
On Solidago Canadensis L. 1893:49.
On Solidago flexicaulis L. (*S. latifolia* L.) 1893:49.
On Solidago patula Muhl. Tippecanoe Co., 6, 1902 (*Arthur*).
On Carex Jamesii Schw. Tippecanoe Co., 4, 1902 (*Arthur*).
On Carex tetanica Schk. Tippecanoe Co., 6, 1899 (*Arthur*).

51. DICÆOMA CHRYSANTHEMI (*Roze*) *nom. nov.*
On Chrysanthemum Indicum L. Tippecanoe Co., 10, 1899 (*Dorner*).

52. DICÆOMA CIRCÆÆ (*Pers.*) *Kuntze*.
On Circæa Lutetiana L. 1893:53. 1896:219.

53. DICÆOMA CONVOLVULI (*Pers.*) *Kuntze*.
On Convolvulus sepium L. 1893:53. 1896:219.

54. DICÆOMA DAYI (*Clint.*) *Kuntze*.
On Steironema ciliatum (L.) Raf. 1893:53.

55. DICÆOMA DULICHII (*Syd.*) *nom. nov.*
On Dulichium arundinacea (L.) Brit. 1893:52.

56. DICÆOMA EATONIÆ (*Arth.*) *nom. nov.*
On Eatonia Pennsylvanica (DC.) Gray. Tippecanoe Co., 5, 1903 (*Arthur*).
On Ranunculus abortivus L. 1893:50.

57. DICÆOMA ELEOCHARIDIS (*Arth.*) *Kuntze.*
On Eleocharis palustris (L.) R. & S. 1893:53. 1896:219.

58. DICÆOMA ELLISIANUM (*Thuem.*) *Kuntze.*
On Andropogon scoparius Michx. Tippecanoe Co., 11, 1898 (Stuart).

59. DICÆOMA EMACULATUM (*Schw.*) *Kuntze.*
On Panicum capillare L. 1893:53. 1896:220.

60. DICÆOMA EPIPHYLLUM (*L.*) *Kuntze.* (*Puccinia Poarum* Niels.)
On Poa pratensis L. 1893:57. 1898:189.

61. DICÆOMA FUSCUM (*Pers.*) *Kuntze.*
On Anemone quinquefolia L. (*A. nemorosa* Mx.) 1894:151.

62. DICÆOMA HELIANTHI (*Schw.*) *Kuntze.*
On Helianthus annuus L. 1893:55.
On Helianthus divaricatus L. 1893:55.
On Helianthus giganteus L. Steuben Co., 8, 1903 (*Kellerman*).
On Helianthus grosse-serratus Mart. 1893:55. 1896:221.
On Helianthus mollis Lam. Jasper Co., 3, 1903 (*Arthur*).
On Helianthus strumosus L. 1893:55.
On Helianthus tracheliifolius Mill. 1893:55.

63. DICÆOMA HELIOPSIDIS (*Schw.*) *Kuntze.*
On Heliopsis scabra Dunal. 1893:54.

64. DICÆOMA MUHLENBERGIÆ (*A. & H.*) *nom. nov.*

65. DICÆOMA WINDSORIÆ (*Schw.*) *Kuntze.*
On Sieglingia seslerioides (Mx.) Scrib. (*Triodia cuprea* Jacq.) 1894:154. 1896:221.
On Ptelea trifoliata L. 1893:50. 1896:217.
On Muhlenbergia diffusa Schreb. 1893:53, 55.
On Muhlenbergia sylvatica Torr. 1896:221.

66 DICÆOMA IMPATIENTIS (*Schw.*) *nom. nov.*
On Elymus Virginicus L. 1893:55. 1896:221.
On Impatiens biflora Walt. (*I. fulva* Nutt.) 1893:50.
On Impatiens aurea Muhl. 1896:217.

67. DICÆOMA KUHNLÆ (*Schw.*) *Kuntze.*
On Kuhnia eupatorioides L. 1893:54. 1896:220.

68. DICÆOMA LATERIPES (*B. & R.*) *Kuntze.*
On Ruellia strepens L. 1893:54. 1896:218.

69. DICÆOMA LOBELIÆ (*Ger.*) *nom. nov.*
On Lobelia syphilitica L. 1893:54. 1896:220.

70. DICÆOMA LUDIBUNDUM (*E. & E.*) *Kuntze.*
On Carex sparganioides Muhl. 1896:220.

71. DICÆOMA MAJANTHÆ (*Schum.*) *nom. nov.*
On Phalaris arundinacea L. Tippecanoe Co., 10, 1889 (*Stuart*).

72. DICÆOMA MELICÆ (*Syd.*) *nom. nov.*
On Melica diffusa Pursh. Tippecanoe Co., 10, 1899 (*Stuart*).

73. DICÆOMA MENTHÆ (*Pers.*) *Gray.*
On Blephilia hirsuta (Pursh.) Torr. 1893:54. 1896:220.
On Cunila origanoides (L.) Brit. 1893:54.
On Mentha Canadensis L. 1893:54.
On Monarda fistulosa L. 1893:54. 1896:220.
On Koellia pilosa (Nutt.) Brit. 1893:54.
On Koellia Virginiana (L.) MacM. 1893:54. 1896:220.

74. DICÆOMA OBTECTUM (*Pk.*) *Kuntze.*
On Scirpus lacustris L. 1894:151.

75. DICÆOMA PAMMELII (*Trel.*) *nom. nov.* (*Puccinia Panici* Diet. and *Æcidium Pammelii* Trel.)
On Panicum virgatum L. 1901:283.
On Euphorbia corollata L. 1893:49. 1901:284.

76 DICÆOMA PECKII (*De T.*) *nom. nov.*
On Carex cephalophora Muhl. Tippecanoe Co., 6, 1902 (*Arthur*).
On Carex stipata Muhl. Tippecanoe Co., 6, 1902 (*Arthur*).
On Carex trichocarpa Muhl. Tippecanoe Co., 11, 1901 (*Arthur*).
On Onagra biennis (L.) Scop. 1893:50. 1896:217.

77. DICÆOMA PHYSOSTEGIÆ (*P. & C.*) *Kuntze.*
On Physostegia Virginiana (L.) Benth. 1894:151. 1896:220.

78. DICÆOMA POCULIFORME (*Jacq.*) *Kuntze.* (*Puccinia graminis* Pers. and *Ecidium Berberidis* Pers.)

On Agrostos alba L. Steuben Co., 8, 1903 (*Kellerman*).

On Avena sativa L. 1893:53. 1896:220.

On Berberis vulgaris L. 1893:49.

On Cinna arundinacea L. Tippecanoe Co., 4, 1901 (*Arthur*).

On Dactylis glomerata L. 1896:220, 223.

On Hordeum jubatum L. 1896:220, 224.

On Poa compressa L. 1893:53.

On Poa pratensis L. 1893:53.

On Triticum vulgare L. 1893:54. 1898:188.

79. DICÆOMA PODOPHYLLI (*Schw.*) *Kuntze.*

On Podophyllum peltatum L. 1893:54. 1896:221. 1898:189.

80. DICÆOMA POLYGONI-AMPHIBII (*Pers.*) *Arth.*

On Geranium maculatum L. 1893:49. 1893:217. 1898:188.

On Polygonum emersum (Mx.) Brit. (*P. Muhlenbergii* Wats.) 1893:55.

On Polygonum hydropiperoides Michx. 1898:184. 1898:189.

On Polygonum lapathifolium L. 1898:184.

On Polygonum Pennsylvanicum L. 1898:184.

On Polygonum punctatum Ell. (*P. acre* H. B. K.) 1893:55, 57.

81. DICÆOMA POLYGONI-CONVOLVULI (*Hedw.*) *Arth.*

On Polygonum Convolvulus L. 1898:184.

On Polygonum scandens L. 1896:223.

On Polygonum Hartwrightii Gray. Steuben Co., 8, 1903 (*Kellerman*).

82. DICÆOMA PRENANTHIS. (*Pers.*) *Kuntze.*

On Nabalus albus (L.) Hook. 1893:55. 1896:221.

83. DICÆOMA PUNCTATUM (*Str.*) *nom. nov.*

On Galium asprellum Michx. 1893:53.

On Galium concinnum T. & G. 1893:53.

On Galium triflorum Michx. 1893:53.

84. DICÆOMA PUSTULATUM (*Curt.*) *nom. nov.*

On Andropogon furcatus Muhl. Jasper Co., 6, 1903 (*Arthur*).

On Andropogon scoparius Michx. Jasper Co., 3, 1903 (*Arthur*).

On Comandra umbellata (L.) Nutt. 1893:50.

85. DICÆOMA RANUNCULI (*Seym.*) *Kuntze*.
On Ranunculus septentrionalis Poir. 1893:55.

86. DICÆOMA RHAMNI (*Gmel.*) *Kuntze*. (*Puccinia coronata* Cda. and *Æcidium Rhamni* Gmel.)
On Avena sativa L. 1896:219. 1898:189.
On Calamagrostis Canadensis (Mx.) Beauv. 1893:53.
On Rhamnus lanceolata Pursh. 1898:184.

87. DICÆOMA SAMBUCI (*Schw.*) *nom. nov.* (*Puccinia Bolleyana* Sacc.)
On Carex lurida Wahl. 1893:52.
On Carex Frankii Kunth. 1893:55. 1898:187.
On Carex trichocarpa Muhl. 1893:52. 1896:219.
On Sambucus Canadensis L. 1893:50.

88. DICÆOMA SANICULÆ (*Grev.*) *Kuntze*.
On Sanicula Canadensis L. 1893:55.

89. DICÆOMA SILPHII (*Schw.*) *Kuntze*.
On Silphium sp. 1893:55.
On Silphium integrifolium Michx. Tippecanoe Co., 8, 1901 (*Dorner*).

90. DICÆOMA SORGHI (*Schw.*) *Kuntze*.
On Zea Mays L. 1893:54. 1898:188.

91. DICÆOMA TARAXACI (*Plowr.*) *Kuntze*.
On Taraxacum Taraxacum (L.) Karst. 1893:53. 1896:219. 1898:188.

92. DICÆOMA TENUE (*Burr.*) *Kuntze*.
On Eupatorium ageratoides L. 1893:55. 1896:221.

93. DICÆOMA THALICTRI (*Chev.*) *Kuntze*.
On Thalictrum dioicum L. 1893:55.

94. DICÆOMA URTICÆ (*Schum.*) *Kuntze*. (*Puccinia Caricis* Reb. and *Æcidium Urticæ* Schum.)
On Carex riparia Curt. Steuben Co., 8, 1903 (*Kellerman*).
On Carex stricta Lam. Tippecanoe Co., 4, 1901 (*Arthur*); Steuben Co., 8, 1903 (*Kellerman*).
On Urtica gracilis Ait. 1898:185.

95. DICÆOMA VERBENICOLA (*E. & K.*) *nom. nov.* (*Puccinia Vilfæ* A. & H.)
On Sporobolus longifolius (Torr.) Wood. 1896:221.
On Verbena stricta Vent. 1896:218.

96. DICÆOMA VERNONIÆ (*Schw.*) *Kuntze.*
On Vernonia fasciculata Michx. 1893:55.

97. DICÆOMA VEXANS (*Farl.*) *Kuntze.*
On Bouteloua curtipendula (Michx.) Torr. 1901:283

98. DICÆOMA VIOLÆ (*Schum.*) *Kuntze.*
On Viola obliqua Hill (*V. cucullata* Ait.). 1893:56.
On Viola striata Ait. 1893:56.
On Viola pubescens Ait. Decatur Co., 5, 1889 (*Arthur*); Tippecanoe Co., 4, 1898 (*Arthur*).

99. DICÆOMA VULPINOIDIS (*D. & H.*) *Kuntze.*
On Carex vulpinoidea Michx. 1893:56. 1896:221.

100. DICÆOMA XANTHII (*Schw.*) *Kuntze.*
On Ambrosia trifida L. 1893:56. 1896:222.
On Xanthium Canadense Mill. 1893:56. 1896:222.
On Xanthium strumarium L. 1893:56.

101. GYMNOSPORANGIUM GLOBOSUM *Farl.* (*Roestelia lacerata* Fr.)
On Cratægus coccinia L. 1893:56.
On Cratægus Crus-Galli L. 1894:153.
On Cratægus mollis (T. & G.) Scheele. (*C. subrillosa* T. & G.) 1898:186. 1898:188.
On Cratægus punctata Jacq. 1893:56.
On Juniperus Virginiana L. 1893:51.

102. GYMNOSPORANGIUM JUNIPERI-VIRGINIANÆ *Schw.* (*Roestelia pyrata* Thax.)
On Malus coronaria (L.) Mill. (*Pyrus coronaria* L.) 1893:56. 1896:218.
On Malus Malus (L.) Brit. (*Pyrus Malus* L.) 1898:186. 1901:255.
On Pyrus communis L. 1893:56.
On Juniperus Virginiana L. 1893:51. 1896:218. 1901:255.

103. JACKYA CNICI (*Mart.*) *nom. nov.* (*Puccinia Cirsii-lanceolati* Schroet.)
On Carduus lanceolatus L. 1893:53.

104. PILEOLARIA BREVIPES *B. & Br.*
On Rhus radicans L. (*R. Toxicodendron* Am. Auct.) 1893:58 1896:223.

105. UROPYXIS AMORPHÆ (*Curt.*) *Schroet.*
On Amorpha canescens Pursh. 1893:58.

Additions to the List of Gall-Producing Insecta Common to Indiana.

By Mel T. Cook.

One year ago the writer presented a list of gall-producing insects, with a list of host plants, for the State of Indiana. This list is no doubt very incomplete, since the writer has collected specimens in Illinois and Ohio which have not been reported from Indiana. Furthermore, this collection of galls which I have received from other parts of the United States and Canada lead me to believe that galls have a very wide distribution; it is probable that the galls are distributed over as wide an area as the host species and, in some cases, are as widely distributed as the host genera. However, the insects may in some cases be restricted to smaller areas, due to other environments. Our knowledge of American galls is at present so limited that it is impossible to draw any definite conclusion on this subject.

Within the yast year I have collected a large number of galls in Illinois, Indiana, and Ohio, but, of course, many of these duplicate those reported in the list of one year ago. I have also received collections from various parts of the United States and Canada, and wish especially to thank Mr. F. L. Sims, of Laporte, Indiana, Mr. C. C. Deam, of Bluffton, Indiana, and Prof. W. A. Kellerman, of Columbus, Ohio, for interesting collections of Indiana galls.

The additional list which I now present gives an increase of two genera and eleven species of insecta.

Hemiptera:

41. Pemphigus populis-caulis, Riley, on Populus deltoides Marsh.
42. Pemphigus populis-transversus, Riley, on Populus deltoides Marsh.

Diptera:

43. Sciara ocellaris, O. S., on Acer saccharium L.
44. Cecidomyia holotricha, O. S., on Hicoria alba L. (Britton.)
45. Cecidomyia tubicola, O. S., on Hicoria alba L. (Britton.)

Hymenoptera:

46. Amphibolips sculpta Bass. on Quercus rubra L.

47. Andricus femoratus Ashm. on Quercus rubra L.

48. Andricus lana Fitch. on Quercus rubra L.

49. Diastrophus nebulosus O. S. on Rubus villosus Ait.

50. Diastrophus cuscutæformis O. S. on Rubus nigrobaccus Bailey.

51. Rhodites dichlocerus Harris. on Rosa sp ——.

Nos. 41 and 42 were collected in Wells County, Indiana, by C. C. Deam; Nos. 46 and 47 were collected near Laporte, Indiana, by F. L. Sims; No. 50 was collected in Steuben County, Indiana, by Prof. W. A. Kellerman, of the Ohio State University. All others were collected by me near Greencastle, Indiana.

No. 12, Trypeta solidaginis of the last report should have been placed under the order Diptera.

I should very much appreciate collections of galls from various parts of Indiana.

Nerve-End Organs in the Pancreas.

By E. O. Little.

The following is an abstract of work done to determine the number, position, and distribution of the Pacinian corpuscles in the pancreas of the cat. Mr. F. C. Jackson sectioned the material and counted the corpuscles.

	Cubic Centimeters of Pancreas.	Number of Pacinian Corpuscles in Pancreas	Number of Pacinian Corpuscles per c. c.
Pancreas, No. I. . .	10 5	72	6.85
" No. II. .	12	43	3.58
" No. III	5 5	25	4.54
" No. IV	5	22	4 4
" No. V	7	85	12 14

Average number of corpuscles in pancreas 49.4, average number of corpuscles in per cubic centimeter of pancreas 6.17.

Ninety-five per cent. of the corpuscles are near the surface of the gland and may be stripped off with the mesentary; 5% are deep in the gland tissue. Of the 95% found near the surface, 28% were near dorsal, 72% near the ventral surface. Only occasionally was a corpuscle found in contact with the intestine.

A Crow Roost Near Richmond, Indiana.

By D. W. Dennis and Wm. E. Lawrence.

What is said in this paper about crows and their roosting is based upon observations taken by Professor Dennis and myself of one particular roost found about three miles south of Richmond, Indiana.

Through the latter part of January, 1903, crows were noticed flying in a direction about south by east in the evening and returning from the same direction in the morning. The evening flight was from 3 to 5:30; the crows were in flocks of from two or three or in a constant stream. The principal line of flight was about one-half mile west of Richmond. By actual count crows passed at the rate of one hundred or more in a minute for more than two hours. They were often so numerous it was impossible to count them. Judging from this there must have been at least 15,000 crows which roosted at this place. By 7 o'clock in the morning nearly every crow had returned from the roost on its way to cornfields, etc., in search of food.

Not far west of Richmond, in a small woodland, they stopped to rest or for some other reason. I have seen crows here by the thousand. It was here at this resting station that very evident exemplification was noted of their fear of man and their signaling to others following. I entered the woods and climbed a tree in order to watch better their maneuverings; however, they were not so kind and not one flew over the tree in which I was stationed. Repeatedly they flew at top speed in a line directly overhead but always, on discovering my presence, made a quick turn, uttered a peculiar call and passed around. This call evidently was a signal for those following to fly in like manner, because for the next few minutes the line passed to one side. Then some crow, not noting the signal, would appear coming directly towards me; but he never failed to make the sudden turn, utter the call and fly around.

This is more clearly brought out by "Driving the line." It was only necessary to walk in a railroad cut under a line of flying crows and it would bend around at a greater distance, the crows at the bend all the

while signaling to those behind. In this manner on one occasion Professor Dennis drove them one-half mile to the west after which they passed on the east. On his return he in like manner drove them an equal distance to the east.

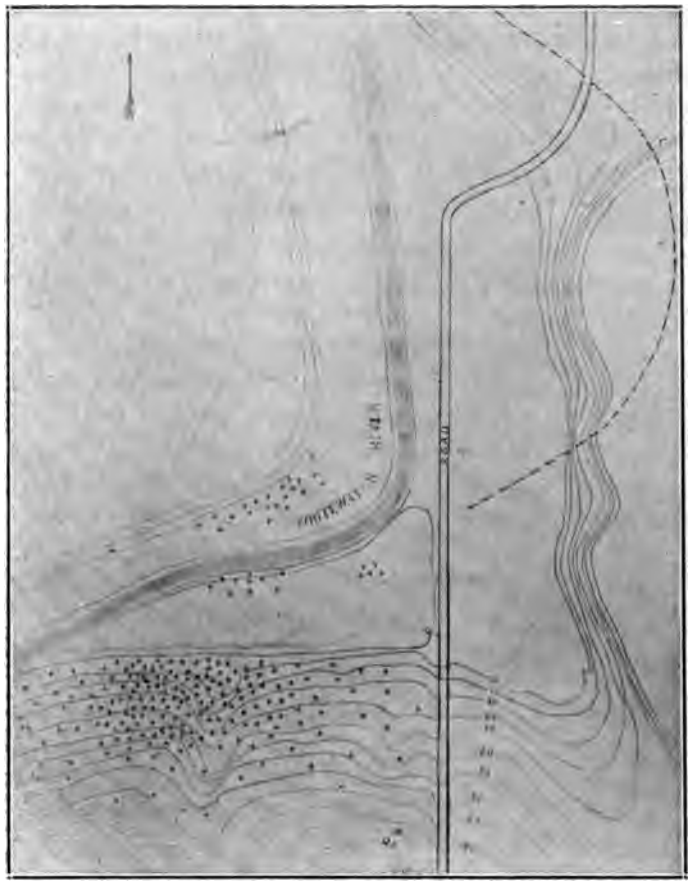
For some reason the crows never went directly to the roost. Whether it was done purposely to conceal the real roost can not be stated. However, they deceived us in this manner and caused us much trouble to find the roost. Three visits were made to the vicinity, two at night and one in the day time. The first visit, February 21st, they were found in a wood and an adjoining cornfield along a small stream of water. As we approached they preceded us. Approaching as quietly as possible, we stopped by a large tree and remained quiet, thinking we might be in the midst of the roost. Gradually all left; meanwhile scouts had been sent to watch us. They would fly directly overhead and then return to give information to the others. The roost was yet to be found. We went to the top of a neighboring hill and saw in the darkness several hundred feet beyond thousands of crows on the snow-covered ground. We could not approach without disturbing them. We did not remain till they went to the trees.

The next time was February 23d, from 6 to 6:30 p. m. We now found all the crows in the trees, most of them across the river from the place where we first saw them, in a large wood, the others in the sycamores along the river quite a distance from the main roost. They must have been doing picket duty, because they uttered no cries, while the others were constantly cawing; also when we purposely disturbed them some of them left silently to join the others.

The last visit, March 2d, was in the day time; the ground was carefully gone over; the boundaries were easily determined by the droppings, examination of which gave good evidence that they were eating a great deal of corn.

The main roost was located on the north side of a hill, 120 feet high, thickly wooded with beech, elm, and ash, and near the foot of this hill. Reference to the map will show that the roost was located in a gorge shut in by hills 90 feet high on the east, 50 feet high on the north and west, and, as before mentioned, 120 feet high on the south. A public road runs north and south to the east of the roost, and, as would be expected, the ground gave evidence of more crows roosting some distance from the road.

This particular hill was only used during the coldest weather; at other times the crows moved about from place to place for their roost. The hill



MAP OF VALLEY OF CROW ROOST.

⁂ Indicates roosting crows.
- - - - - - Indicates path of crows entering the valley.
Contour lines 10 ft. apart.

and the elevation of the surrounding land (as shown in the map) certainly furnished protection against the cold.

The crows began to arrive about 4 p. m., alighting in the neighboring trees and along the river bank, drinking water and picking pebbles. The

main line seemed to arrive from the northeast and from no other direction. But, to our surprise, on our way home after leaving the valley, it was discovered that the crows from the northwest were flying southeast on a tangent with the valley and alighting in the trees and fields to the east; then turning at almost right angles they flew over the hill down into the valley where the roost was. Was this purposely done for protection?

In conclusion the main things to be noted are the bending of the line when men are seen; the signaling of danger to the oncoming line; that the crows never approached the roost directly and that they only roosted on the hillside during the coldest weather.

Some New Forms of Physiological Apparatus.

By J. F. Woolsey.

All branches of scientific work require special apparatus to fulfill their particular needs. The apparatus here shown was devised to meet certain requirements for adjustable apparatus, for use with the kymograph, in recording physiological experiments. It is apparently desirable in this work to have as many adjustments to the apparatus as possible, the solidity of the apparatus being unimpaired.

ADJUSTABLE STAND.

This stand consists of a base 5½"x8"x1"; a standard 18" high and 1" in diameter, to which is attached, by means of arms, the swinging rod upon which is supported, by means of universal clamps, the various forms of apparatus used in making the records upon the smoked drum of the kymograph. The entire stand weighs 15 pounds.

The swinging portion of the apparatus deserves special notice. Figure 2 of the mechanical parts serves as the top arm, and the upper plate of the lower arm. It is 3½" long and 1⅝" wide at the broadest part. Figure 1 is the lower plate of the lower arm, and is proportional in size to the upper plate. Figures 3 and 4 show the entire mechanism. In Figure 3, (a) is the coarse adjustment, and by releasing the set-screw the swinging rod (d) can be revolved about the standard (c); the desired pressure of the stylus against the drum of the kymograph is obtained by the manipulation of the more finely-threaded screw (b). In Figure 4, (b) represents the fine adjusting screw, and (f) the strong coiled spring, which operates the swinging rod attached to (g), as shown in Figure 3. The swinging rod is 14" long.

The University of Pennsylvania uses adjustable stands, devised and made by themselves, but the entire movement of the swinging rod is obtained from the bottom, and the mechanism is entirely different from

the above. Credit is due Mr. R. P. Hobbs for his assistance in devising the mechanical parts.

FROG TABLES.

These tables are modifications of those used in the University of Pennsylvania, and meet certain requirements better. They consist, Figure 6, of a brass plate 4½"x8", to which is glued a single piece of cork ½" thick, and the adjustable arm or support. The adjustable part consists of a brass block (c) which slides upon the square rod (e), the set-screw (b), and has a horizontal play of 4½". The set-screw (a) allows of a further circular movement of the plate, and the square supporting arm is held to the stand by a universal clamp.

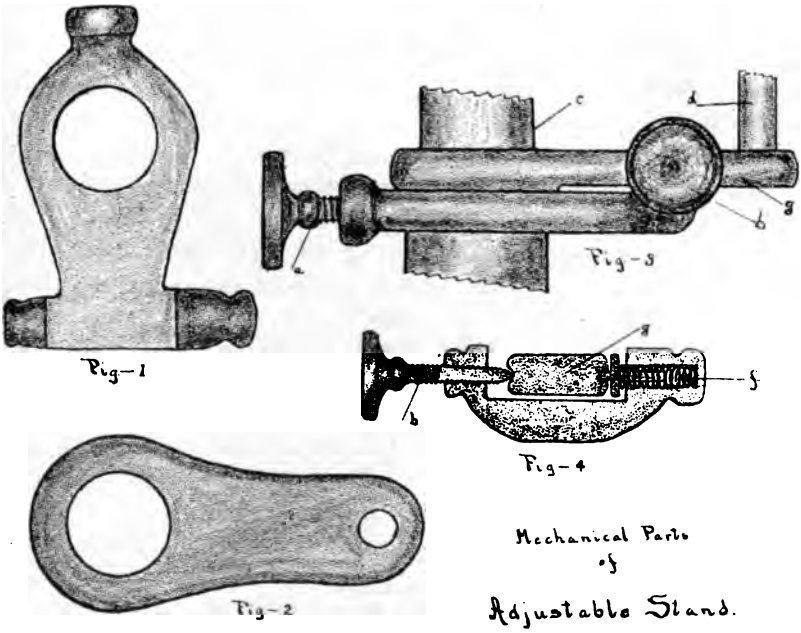


Fig. 5. Adjustable Stand.

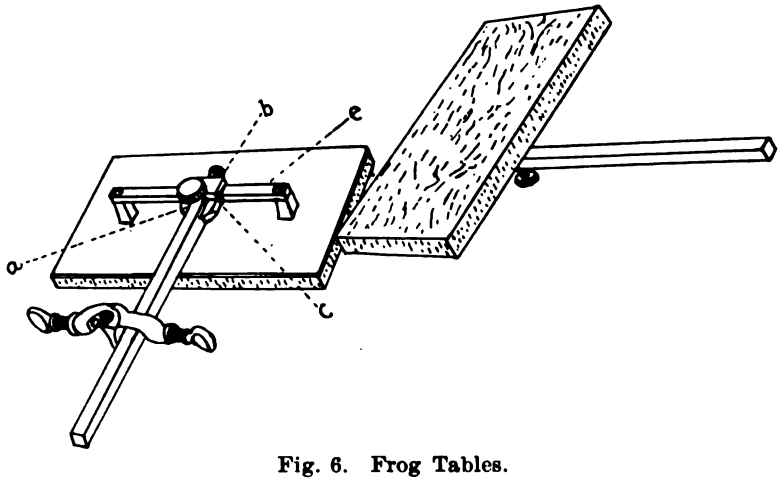


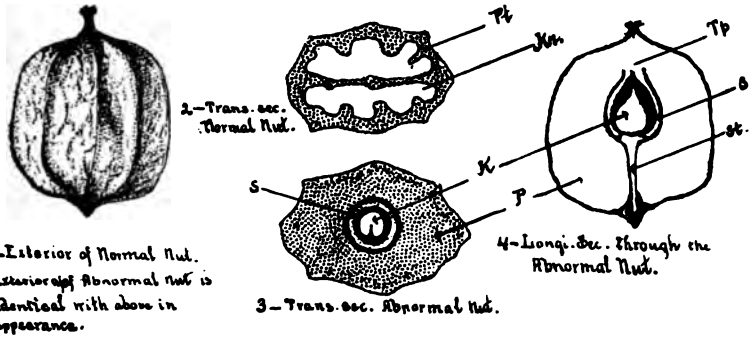
Fig. 6. Frog Tables.

An Abnormality in the Nut of Hicoria Ovata (Mill) Britton.

By John S. Wright.

The abnormal hickory nut figured and described here was one of a lot purchased in the market. In all outward appearances it was normal, the peculiarities were noted in cracking it. Fig. 2, a transverse section of a normal nut, shows the relative proportion of shell and seed. Fig. 3, transverse section of the abnormal fruit, shows the cavity one-celled and greatly reduced by the thickened walls (P). Figs. 3 and 4 show the interior filled with a nut somewhat like that of the hazel; (s) the walls hard and shell-like, and (K) the kernel, folded as indicated by the convolution on one side. The kernel had a bland, oily taste, faintly resembling that of the hazel nut. At the apex the tissues of the shell of this smaller nut appear to be continuous with those of the outer shell (Tp). The inner nut had a pedicel, indicated (st) in the figure. In cracking, this pedicel separated from the body of the small nut along a definite line. The shaft of this pedicel reached through the thick outer shell and readily separated from the surrounding tissues.

In view of the fact that the hickory nut is not extensively cultivated and apparently has not been observed hybridizing to any extent, or otherwise modified by breeding, the occurrence of this deviation from the type is deemed worthy of notice.



Bird Nests of an Old Apple Orchard Near Indiana University Campus.*

By Gertrude Hitze.

As part of my work in Nature Study during the Spring of 1902 I was assigned an old orchard east and north of Indiana University Campus. My work was to locate and report on all of the birds' nests of this orchard.

As a preliminary a plot was made of the orchard. The rows of trees were numbered serially from 1 to 22, and the individual trees in each row were also numbered. The orchard was thoroughly searched for nests between the latter part of April and the early part of June. The exact location of the nests is omitted in this report.

From an ethical and sentimental standpoint the work was very discouraging. Two-thirds of the nests were not completed or were destroyed in different ways. In all, 24 nests were found, and 18 of these came to grief in one way or another, as the report will show.

The report will be of interest as showing the vicissitudes of birds near a town, and the expense at which birds become and remain adapted to their environment.

TURTLE DOVE.

May 21st I found a nest loosely made of twigs, lined with hay and feathers, and containing two pure white eggs. May 23d this nest was robbed and destroyed. The old birds were flying about the orchard. On June 2d I saw no doves in the orchard.

CHIPPING SPARROW.

May 21st I found a little nest under a grapevine. It was built of dry grasses and lined with horsehair. The nest was built in a little hole in the ground. It contained one white egg with many brown

*Contributions from the Zoölogical Laboratory of Indiana University. No. 61.

spots. May 23d this nest had been robbed like so many others. The nest was not destroyed but the birds never returned.

May 23d I found a nest under another grapevine. The nest had four eggs in it. Two of the eggs were pipped. June 2d four little birds were in the nest, one of them with a lady beetle in its mouth. June 4th, birds almost feathered. They seemed not to be afraid of me as I drew near them. The mother did not go far from the nest as long as I was near. June 8th, the birds have flown. There were *six* little birds hopping about in a tree near the deserted nest.

SONG SPARROW.

May 23d, along the north fence I found a nest in a grapevine, nicely hidden among the leaves. The nest was made of twigs lined with dry grass. There was one white egg, spotted with heavy brown spots. June 2d, two eggs were in the nest. No bird was near at this time. June 4th, the nest had been robbed but not destroyed. No birds were near.

WHITE-THROATED SPARROW.

On April 30th I found a White-throated Sparrow building a nest in a brush heap. The bottom of the nest was finished and made of twigs. Every time the Sparrow carried any material to the nest a Catbird would fly down and take it away. The Catbird fought and chased the Sparrows until they left the nest unfinished.

HOUSE WREN.

May 21st, in the southeast corner of a shed I found a nest in the old woodwork. The nest was made of dry roots lined with chicken and turkey feathers. There were seven young almost feathered and nearly ready to fly. May 23d, the birds have flown.

CRESTED FLYCATCHER.

May 7th I saw two Crested Flycatchers flying around an old tree. They were building a nest, for one carried a feather, while the other flew at me whenever I came near them. I was unable to find their

nest. May 9th I looked again for the nest but was unable to find it. May 21st I found the nest in a hole in the old tree. It was in a dead limb at a depth of about twelve inches from the opening. It was lined with feathers. There were five light eggs with heavy brown markings, especially at the large end. May 23d, no change in the nest. The birds were near. June 2d, five little birds were in the nest. June 9th, birds are just ready to leave the nest. June 11th, birds have flown.

BROWN THRASHERS.

I found a nest in a brush pile on April 23d. The nest was made of twigs lined with dry grass. There were three eggs with brown specks, more spots at the large end. On April 30th the nest had been robbed and no birds were near.

On April 30th I found another nest in another brush heap. There were two eggs in it. The mother remained hiding in the brush. On May 5th I found the brush pile was burned and the birds gone.

On May 7th I found an unfinished nest in still another brush pile. May 9th, the nest was finished but no bird was near. May 14th, four eggs in the nest with the Brown Thrasher on the nest. She was not a bit shy, and allowed me to come quite close to her. She then hopped off the nest and from twig to twig, and out upon the ground, and then flew away. The male sat off at the other side of the orchard and sang very merrily. May 16th, the female was still upon the nest, the male was very happy as he sat up in the tree and sang. May 21st, the nest had not been destroyed. The bird was quite friendly, as she would sit and allow me to talk to her. On the 23d I found that some boys had been in the orchard. They had robbed and destroyed all the nests. This one was not spared. The birds have disappeared.

On May 7th I found the foundation of a nest in a tree, nicely hidden by leaves. It was built of large twigs and lined with a few dry grasses. The nest seemed deserted. On May 9th no birds were near and no work had been done on the nest. June 1st, the birds had been working on the nest. It had been entirely relined. June 5th, one egg, blue, flaked with brown, was in the nest. June 9th, there were

three eggs in the nest. The mother bird was quite nervous when I was near the nest. No further observations were made on this nest.

CATBIRD.

On May 2d I saw two Catbirds weaving straws into a nest. May 5th, the nest was gone. Catbirds not near. I believe they are hard to please, for they begin a nest and then desert it, sometimes leaving the foundation and other times entirely destroying every trace of it.

On May 7th I found a nest made of twigs and dry grass with Catbirds near it. On May 9th this nest was partially destroyed. The birds were gone.

On May 7th I found a nest in a tree. I chased the birds off from the nest to find two greenish eggs in it. The eggs were smaller than the Robin's eggs. The old birds fought me. May 9th, no change in the nest. Birds fought even harder than the last time. May 14th, one egg was pipped. May 16th, I climbed the tree. No birds flew at me, and I soon found that, like so many other nests, this one had been robbed. The eggs were gone. No shells nor birds were near.

On May 7th I found an unfinished nest. It was nicely hidden by leaves. It was built of twigs and a few dry grasses; no birds were near. This nest was deserted, as no more work had been done and no eggs were found in it on later visits.

On May 9th I found the fifth Catbird's nest. It contained one egg. No bird was near to fight. On May 14th two eggs were in the nest, and on May 16th the eggs had been broken and the nest torn up. No birds were near.

The sixth nest was found on May 9th. It contained one egg, but no bird was near to fight. On the 14th the nest had two eggs in it, but they were broken and the nest was destroyed.

On May 14th I found a nest quite high in the tree. There was one egg in it. May 21st, the egg was gone; it looked as though it had been broken. The inside of the nest was torn out.

On May 21st I found a newly built nest. The Catbirds were in the tree and seemed very interested in the nest. On May 23d the nest was destroyed and no birds were near.

ROBIN.

On April 21st, 1902, a Robin's nest was found on the rail of a fence, about four feet from the ground. The nest was made of roots, dry twigs, dry grass, plastered together and to the fence with clay. Softer grass was used in the center. Two blue-green eggs were in the nest, their small ends toward the center of the nest. On the 23d the bird was on the nest when I made my round, but she flew off. There were four eggs in the nest, and just as soon as I left she flew back. On the 30th the nest was found to have been torn from the fence and thrown upon the ground. The eggs were broken. No birds were noticed near this place again.

On April 14th I found an unfinished nest in a tree. It was being constructed like the one above described. Birds working hard. April 17th the nest was completed, but the birds were not near. April 21st I found one blue-green egg in the nest. April 23d I found that three eggs had been laid but had been broken, and the shells were on the ground near and far. The nest was wet with the white of the egg, and the inside of the nest destroyed. I was unable to find the cause of the nest being destroyed. Nothing further was done on this nest by the birds up to the end of the observations.

On April 17th I found a nest in a tree which had been completed. The Blue Jays and the Robins were fighting, the latter being driven away. On April 23d I found a Robin on the nest sitting on one egg. April 30th I found the bird sitting on three eggs. The Robin seemed quite friendly, for she allowed me to come very near to her. Then she flew only after I made a motion as though to touch her. May 2d I found the bird sitting on four eggs. May 5th the Robin was still on the nest. She allowed me to come quite near. May 7th, two little Robins in the nest; the other two eggs were pipped. May 9th, four little birds. They seemed all mouths and eyes. The mother flew as soon as I came near the nest, but did not go more than five feet. The male followed me a long distance. This was the first time he had shown fight. On March 14th, the birds have grown very much. They would not take anything from me. Both the old birds tried to fight, and as I left the nest the male followed. May 16th the birds were nearly feathered; very shy. May 17th, all the

birds have flown. In just one month from the time I found the nest all trace of the birds was gone. It was twenty-four days from the time the first egg was laid in the nest until the nest was empty.

On May 4th I found a Robin's nest up high in the tree. Made like those above described. May 7th I found four blue-green eggs in the nest with the female on the nest. On May 14th two of the eggs were pipped. The mother was very nervous. On May 16th four little birds were in the nest. On May 21st the little birds were nearly feathered, and on the 23d the birds nad flown.

BLUEBIRD.

May 21st I found a nest with one blue egg in an old and partially hollow tree. It was in a cavity on the east side about ten inches from the opening. The nest was lined with fine feathers, but in pulling off the bark much of the loose, decayed stuff fell into the nest. May 23, the nest has been robbed and the lining pulled out.

List of Mammals, Reptiles and Batrachians of Monroe County.

By Waldo L. McAtee.

(By title.)

Ecological Notes on the Mussels of Winona Lake.*

By T. J. Headlee and James Simonton.

In the summer of 1903 the writers, under the direction of C. H. Eigenmann, made observations on the mussel distribution of Winona Lake with a view to determining the reason for the same. We examined the shore line from 4 inches to 4 feet by wading, from 4 to 7 with a clam rake, from 7 to 86 feet with an iron dredge.

The species found were determined by comparison with shells that had been named by Call, Simpson and Baker. The nomenclature is that used by Call in his report on Indiana Mollusca, Geological Report, 1899. They were: Unio luteolus, Unio subrostratus, Unio glans, Unio fabalis, Unio rubiginosus, Anodonta grandis, Anodonta edentula Margaritana marginata.

This is a deep kettle-hole lake. In general the beaches are composed of sand and gravel, which shade off with varying rapidity into marly sand, then into sandy marl, then into coarse white marl, and finally into the fine dark marl that covers the bottom in all the deeper parts of the lake and which is the accumulation of plankton tests. The bottom steadily grows softer as the proportion of dark marl increases. So soft does it become that a small sounding lead sinks into it of its own weight from 6 to 12 inches. In some places, especially the southwest side and in the little lake the shallow part of the beach is formed of muck which shades off into marl without the presence of any sand or gravel.

In general it may be said that the mussel zone extends from the shore line to where the bottom changes to very soft marl. This region will average from 4 inches to 9 feet of water, although in some places the mud comes to within a few feet of the water's edge, while in others the sandy and gravelly bottom runs out into 22 feet of water.

A. grandis is usually found just on the outer edge of the sand and gravel bank, while A. edentula appears most numerously a little farther out. A few specimens of both species were taken closer in shore,

*Contributions from the Zoölogical Laboratory of Indiana University, No. 62.

grandis being sometimes found on sandy bottom, edentula, however, invariably upon a soft bottom. Neither (healthy forms) was ever taken on hard sand or gravel.

U. glans has been taken upon sandy and gravelly bottoms, in from 4 feet out. U. fabalis appeared in about the same region except that it goes out on the soft bottom even farther than edentula.

U. subrostratus appears on the outer edge of the sand and gravel banks in about four feet of water and extends out as far as the light form of U. luteolus.

U. luteolus is the most variable, the most widely distributed and the most abundant species in the lake. It varies from a moderately thin, light straw-colored shell, marked by radiating greenish lines, to an extremely heavy, almost black form. The gradations of form, color, and size are shown in the plate and are very nearly perfect. The straw-colored variety is found in from 4 inches to 22 feet of water; it is, however, dominant inshore, in weed patches (Potomogeton and Ceratophyllum), and on chara-covered bottoms. The dark variety occupies the same region but is dominant upon sand and gravel bottoms in from three and one-half to twenty-two feet of water. The intergrading forms cover the same territory as the straw-colored and dark varieties but can not be said to be dominant anywhere.

U. rubiginosus occupies about the habitat dominated by the dark form of U. luteolus, except that it was not found in deeper water than ten feet.

M. marginata was found so infrequently (only six times) that the writers could tell little of its distribution. The specimens found were taken on sand and gravel, and white marl bottoms in from four to twenty-two feet.

There are a number of conditions in the environment which suggested themselves to us as possible explanations for this distribution —age, sex, light, heat, food supply and oxygen, pressure, wave action, character of the bottom, and enemies. Sex can not be important, for males and females are found together throughout the habitat; light can have but little to do with it, for mussels are absent in places in three feet of water and are abundant in others in fifteen feet, the difference in light being considerable. Further, the light over some of the immense beds in White River is no greater and perhaps even less than in twelve feet of lake water. That heat has little effect, during the summer at

least, is shown by the fact that heavy beds were found in different temperatures, and by the fact that temperature variation in the mussel zone did not amount to more than two degrees; oxygen is not important, for the supply of oxygen throughout the mussel zone varies very little; pressure can have but little to do with it, for we found specimens on a sandy bottom in twenty-two feet of water, while on dark marl bottoms in ten feet none were taken in any case. Food supply can not be effective, for it is about equally abundant throughout the zone. The food consists principally of diatoms; secondarily of low algæ forms, and one-celled animals.

It seems to us that there are three causes which control the distribution of mussels as it appeared in Winona Lake—wave action, character of the bottom and enemies.

The first cause applies only in water less than three feet deep. As U. luteolus and A. grandis appear in this region they are subjected to this agency. Specimens of both A. grandis and the dark form of U. luteolus have been found washed ashore after a storm, and scores of these shells appear along the shore line. Under similar conditions we have seen the light form of U. luteolus moving from the water's edge out into deeper parts; these facts point to the conclusion that the two first mentioned forms are prevented from occupying shallow water by wave action, but that the light form of U. luteolus, being very active and having a thick shell, can well occupy this region. Not only is washing ashore fatal to A. grandis, but wave action quickly action quickly wears away the shell and leaves the animal open to attack. Unio glans, fabalis, edentula, and subrostratus are very light and slow moving; U. rubiginosus is heavy and clumsy, like the dark form of luteolus; the first three, if washed ashore, would be unable to get back, and their shells would be unable to resist the wearing action of the waves, while the last mentioned form could resist wave wearing but would be unable to get back if washed ashore.

The character of the bottom applies throughout the mussel zone. The bottom in the weed patches differs from that in the deeper parts of the lake in being slightly less soft. The sandy and gravelly bottom affords firm foothold and allows the mussel to assume that position which enables it to get the best supply of food and oxygen, while the pure marl allows it to sink so far as to be smothered. Even if the animal does not sink entirely under, the overlying sediment is suf-

ficient to smother it. That there is an overlying sediment is shown by the following experiment: We pumped water from twelve and six inches above the sandy and gravelly bottom in seven, ten, fifteen, twenty-five feet of water; the specimens revealed no sediment that would not settle on standing. Specimens were taken in thirty and thirty-six feet of water over a marl bottom and the twelve-inch samples yielded a small amount of such sediment, while the six-inch samples showed a decided amount. That matter in suspension is fatal to the mussel is shown by the fact that we found in the west side and south end of the lake what were evidently once thriving mussel beds, buried under a thin layer of coarse marl, which had been stirred up by the action of the steam dredge two years before. These mussels were found in the normal position undisturbed in any way. That the mussels were alive five years ago is shown by Dr. Moenkhaus' statement that he and his classes collected an abundance for study in those same regions at that time.

In order to test the ability of the mussel to stand these bottom conditions we made three wire clam baskets, lowered one in twenty-five feet of water, another in thirty-five feet, another in eighty-five feet. We got the following results:

August 5, a basket containing thirteen U. luteolus and one A. grandis was placed in 25 feet of water on a dark marl bottom. On the 10th two examples of U. luteolus were dead; on the 15th one U. luteolus was dead; on the 17th two U. luteolus were dead and four were missing.

August 9, a basket containing five U. luteolus of the light variety and one of the dark, and one A. edentula was lowered in 35 feet of water on a sandy gray marl bottom. On the 15th, one A. grandis and one U. rubiginosus were added. On the 20th one U. luteolus of dark variety was dead; on the 24th five U. luteolus and one U. rubiginosus were found to have the gills badly choked with sediment, while the anodontas were missing.

August 15, a basket containing seven U. luteolus of light and one of dark variety, two A. edentula, and one A. grandis was lowered in 85 feet on a pure dark marl bottom. On the 21st one U. luteolus of dark variety was dead; on the 24th seven U. luteolus and one A. grandis showed gills badly choked with sediment, while the two edentula were in better condition, showing very few patches of marl in gills.

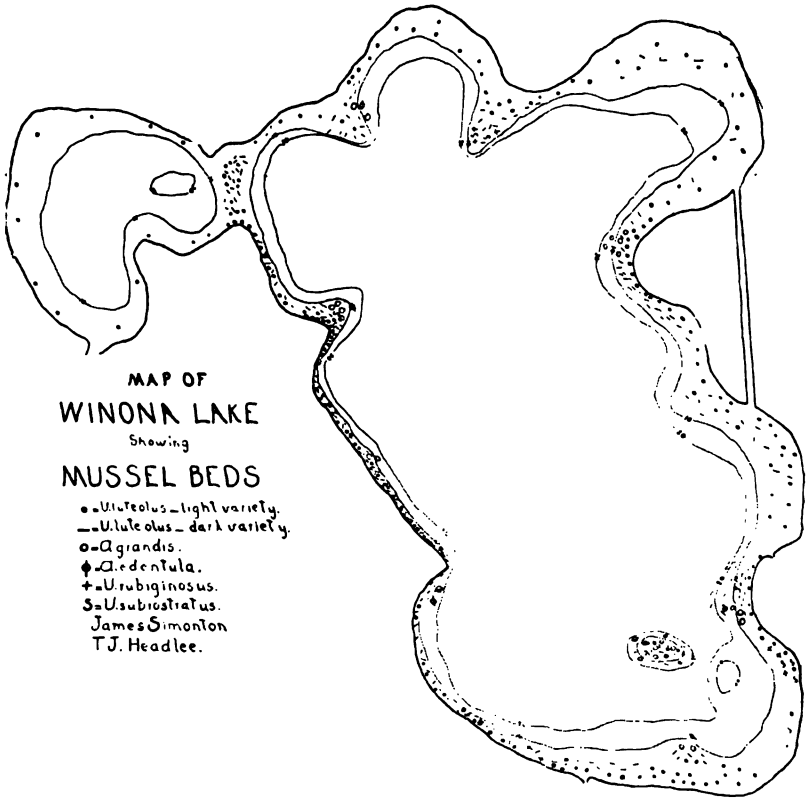
To sum up: In the basket in twenty-five feet, lowered on dark marl, in nineteen days five were found dead and four missing; in the basket in thirty-five feet, lowered near Sandy Point on a sandy gray marl bottom, in fifteen days one was dead, all showed gills partly filled with sediment; in the basket in eighty-five feet, lowered on pure dark marl, in nine days two were found dead and the gills of all but A. edentula badly choked with sediment. U. fabalis, U. glans and U. subrostratus were not included in this experiment because the first two would have slipped out through the meshes and the third could not be obtained at the time. However, it seems reasonable to suppose that they would have proven not unlike the others. It seems, therefore, that those forms possessing light weight in proportion to surface exposed and close-fitting valves are best able to resist the soft marl and the overlying sediment.

A. grandis and edentula, having light and close-fitting valves, are found accordingly on the outer edge of the sandy marl bank; the edentula, being better fitted to withstand the bottom conditions, is found out in the edge of the dark marl. U. glans and fabalis, owing to lightness and close-fitting valves, occupy about the same situation, the fabalis having much the lighter shell, being found out as far or farther than the edentula. They are also found inshore, where not subjected to wave action. U. subrostratus, having medium weight valves, which are also close-fitting, is confined to the gravel and sand banks, weed patches and chara-covered beds. U. rubiginosis, having very heavy and rather loose-fitting valves, is confined to clear sand and gravel banks. The dark form of luteolus, having extremely heavy and rather loose-fitting valves, is confined to hard sand and gravel banks. The straw-colored form by its medium weight and tight-fitting valves is able to live on sand, gravel, in mud patches and on chara-covered bottoms. Owing to the fact that so few specimens of M. marginata were found we were unable to draw any conclusions as to its ecology.

The muskrat is the principal enemy of the mussels; around his house many mussel shells are found, but no live mussels. Shells of all the species in the lake except the smaller ones are found, the Anodonta shells being in much greater evidence than is proportionate to their total number. They do not appear so on first examination, for they are broken up by the animal and worn by the waves. The conditions on the sand banks beyond reach of wave action are very favor-

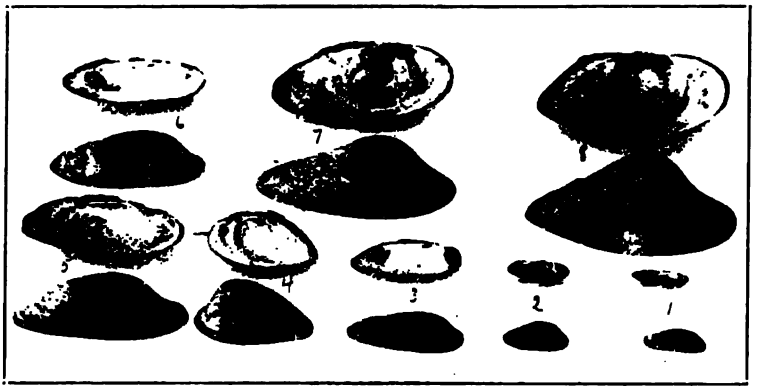
able for Anodonta life, except for the presence of the muskrat. Anodontas are absolutely absent from water some distance from his home, where we found Unios rather abundantly. This points to the fact that the muskrat confines the Anodonta to the deeper waters at the edge of the sandy and gravelly banks.

It seems to us that the foregoing facts give basis for the following conclusions: First, that the mussel zone lies mainly upon sandy and gravelly banks, and on the outer edge of the same; second, that wave action and the muskrat determine the limit of the distribution shoreward, and that the character of the bottom is the principal factor determining the outer boundary of the zone.



EXPLANATION OF PLATES.

PLATE I.



1 Unio fabalis; 2 Unio glans; 3 Unio subrostratus; 4 Unio rubiginosus; 5 Margaritana marginata; 6 Unio luteolus; 7 Anodonta grandis; 8 Anodonta edentulus.

PLATE II.

1, 2, 3, and 4 are pairs of U. luteolus, which exhibit gradations of form, color and size from the light straw-colored forms to the almost black variety.

a, b, c, d, e, f, g, and h exhibit the gradations of color and markings found, from white to dark varieties, without regard to sex.

Conditions Effecting the Distribution of Birds in Indiana.*

By Amos W. Butler.

GENERAL CONDITIONS.

The regular annual movements of birds, their migrations, are among the most striking of the manifestations of Nature. With the revivifying breath of spring, the absent birds return. Last fall, when the summer's work was done, they went to warmer climes. Now, they seek anew their breeding grounds. Some make their homes with us; others go farther north to rear their young. The semi-annual ebb and flow of these tides of bird-life, the breeding range and the food supply are general factors that enter into the distribution of birds everywhere. Our ancestors noted them as signs of the seasons. They exist today, though we do not see them so readily because of our changed conditions.

ZOÖLOGICAL AREAS.

Indiana is a meeting-ground of various birds. Into it range typical forms of different zoölogical regions. From the west, are prairie birds; slightly tinging the north, are northern forms; while the dominating influence of the lower part of the State is southern. Indiana lies within the eastern (Atlantic) faunal province. According to Mr. Allen, it is distinctively Carolinian (Bull. Mus. Comp. Zoöl. II, No. 3, pp. 393-395), yet the southwestern part is within the range of many birds characteristic of the Louisianian Fauna (Austroriparian Province of Prof. Cope, Bull. U. S. Nat. Mus. No. 1, 1875, pp. 67-71). Dr. Merriam would include the bulk of the State in the Upper Austral Zone, the Lower Austral Zone reaching into southwestern Indiana and the Transition Zone influencing the northern part (Bull. No. 10 Biol. Surv. U. S. Dept. Agr. 1898).

*Contributions from the Zoölogical Laboratory of Indiana University, No. 37.

DISPERSAL BY STORMS.

Following heavy storms, of wide extent, at sea, it sometimes happens that birds are blown or driven far inland. This, in part, accounts for the unusual occurrence, at times, of numbers of certain birds. One of the most notable instances of this was the wide dispersal of Brünnich's Murres (Uria lomvia) by a north-Atlantic storm, in December, 1896. They were driven as far south as South Carolina and over the eastern United States, at least to Indiana and Michigan. A number of specimens were taken in Indiana (Butler. The Auk, XIX. 1897, April. 197-200).

CHANGES IN CONDITIONS.

The birds about us are not those that were familiar to our fathers. Many kinds that were common to them have disappeared. Others that they did not know have come to take their places. In the early days of our history, dense forests stretched unbroken, save by water courses, from the Ohio River northward almost to Lake Michigan. Through these, threaded the runways of wild animals and the trails of wild men. Within the gloom of these continuous woodlands dwelt birds peculiar to such surroundings. With the clearing of our land, there disappeared from that area many forest-inhabiting birds. The range of others became restricted to the remaining timber districts. Meadows and pastures replaced the forests. Birds loving such surroundings, prairie forms, there made their homes.

The beautiful little Carolina Paroquet (Conurus carolinensis), which once ranged in countless numbers throughout the eastern United States, as far north as the Great Lakes, has not only disappeared from our limits, but also from almost every part of its range. From but a few almost inaccessible localities in the Southern States has it been recently reported, and it is now on the verge of extinction. It was last reported in Indiana from Knox County in 1859 (Hasbrouck. The Auk, VIII. Oct. 1891, pp. 369-379; Butler. Ibid, IX. Jan., 1892, pp. 49-56).

The Ivory-billed Woodpecker (Campephilus principalis), the largest representative of its family, was found in the early part of this century in suitable localities in southern Indiana, notably in Franklin and Monroe counties and in the lower Wabash Valley. Their shy, retiring ways led them to leave when men appeared bearing the evidences of civilization.

They have almost entirely disappeared from earth. A few individuals linger among the almost inaccessible regions of the Southern States (Hasbrouck. The Auk, VIII. 1891. pp. 174-176).

The Pileated Woodpecker (Ceophlœus pileatus), known to the early settlers as Logcock and Black Woodcock, was familiar to the eyes and ears of the early colonists. They were averse to sharing their haunts with the white man. Less and less their numbers grew. They disappeared from one locality after another, until now but few are left in the more sparsely settled districts of the State (Butler. Birds of Ind., 1897, p. 838).

The croak of the Raven (Corvus corax sinuatus) was a familiar sound to the early pioneers. They saw its numbers lessen from year to year, until their children, now, never see its form and do not know its voice. From one locality after another, the few remaining birds have disappeared, until at this time it is probable that none are to be found within the State. Until within the last five or six years, they have been known to nest in Martin and Dubois counties, but I can learn of none having done so since (Proc. Ind. Acad. of Sci., 1897, p. 202).

The Wild Turkey (Meleagris gallopavo), our most noble game bird, has been generally extirpated, although it is still reported from Knox, Gibson and other counties of the lower Wabash Valley. It, probably, is also to be found, in rare instances, in some of the wilder regions, elsewhere, in southern Indiana. It formerly was numerous throughout the State.

The Swallow-tailed Kite (Elanoides forficatus) is known but to few. In 1812, Alexander Wilson reported these graceful, giant, swallow-shaped birds as abundant upon the prairies of Ohio and Indiana Territories (Amer. Orn., VI, 1812. p. 70). For seventy years after that but one was reported from Indiana (Haymond. Proc. Phil. Acad. N. S., Nov., 1856. p. 287). Since then they have been seen at irregular intervals in the southern two-thirds of the State.

Wild Pigeons (Ectopistes migratorius) were formerly found in such countless numbers that no estimate could be made of their abundance. During the season of their flight, flocks of enormous size successively passed, obscuring the sun and sometimes hiding the sky. At night, they gathered in roosts in favorite localities. These roosts were often of great extent. They alighted upon the underbrush, crushing it to the ground, and so weighted the trees that limbs of large size were broken off by the

burden put upon them. After the first third of the century, their numbers began noticeably to diminish; but few large flights were seen in our State after 1870. Ten years later, they had almost disappeared. Now, they are nearly extinct. A few individuals are to be found in certain localities in the rougher portions of southern Indiana (Proc. I. A. S., 1899).

In the extreme northern part of the State, prairies and swamps, lakes and woodland alternate. The marshes and lowlands of northwestern Indiana form attractive spots to many swamp birds and waterfowl. Different kinds of ducks collect there and a number of species breed in the more retired places. Formerly, they were much more numerous. There, also, the Whooping (Grus americana) and Sandhill Cranes (Grus mexicana) bred in numbers. Snipe and Plover were found abundantly. Phalaopes and Black Terns (Hydrochelidon nigra surinamensis) frequented the lakes and ponds. Gallinules, Coots and Grebes still rear their young. Rails of four species make their homes among the reeds. Marsh Wrens and both the American (Botaurus lentiginosus) and Least Bitterns (Ardetta exilis) frequent the sedges; while the stems of these plants are drawn together to form nesting places for the Red-winged (Agelaius phœniceus) and Yellow-headed Blackbirds (Xanthocephalus xanthocephalus), and their tops are woven into the globular nests of the two species of Marsh Wrens. The dryer marshes are the breeding grounds of such rare forms as Henslow's (Ammodramus henslowii) and Nelson's Sparrows (Ammodramus candacutus nelsoni). The swampy woodland is the home of other water-loving species. Among the tops of the tallest trees are still to be found the small remnants of large colonies of Great Blue Herons (Ardea herodias) and Black-crowned Night Herons (Nycticorax nycticorax nævius). Here, too, we have recently learned that the beautiful White American Egrets (Ardea egretta) commonly made their homes, nesting in colonies or heronies. By this fact, its known breeding range is extended northward a distance about equal to the length of this State (Proc. I. A. S., 1897, pp. 198-201). Among the tree-tops, too, were to be found the nests of the Osprey (Pandion haliætus carolinensis) and Bald Eagle (Haliæetus leucocephalus). In the larger cavities in the tree trunks, the Wood Ducks (Aix sponsa) still rear their broods, and the deserted Woodpecker holes in the old snags are occupied by White-bellied Swallows (Tachycineta bicolor) and Prothonotary Warblers (Protonotaria citrea).

All this has greatly changed. Some of these characteristic forms have almost disappeared, while the draining of the swamps and the reclaiming of the land have lessened the area favorable for the homes of others. Few, indeed, are the numbers of most of these birds in this region compared with the innumerable company that occupied it a half century or more ago.

Field Sparrows (Spizella pusilla), Vesper Sparrows (Poocætes gramineus), Dickcissels (Spiza americana), Grasshopper Sparrows (Ammodramus savannarum passerinus) and Meadowlarks (Sturnella magna) are representatives of those that sought the fields with which man replaced the native woods. Others, such as the Bobolink (Dolichonyx oryzivorus) and Prairie Horned Lark (Otocoris alpestris praticola), also extended their range as favorable localities were found. At the time of the settling of our State, the breeding-grounds of the Bobolink within our present limits were probably about the southern end of Lake Michigan, extending southward over the prairies of the Kankakee Basin and eastward as far as the site of Rochester. Possibly some bred in the smaller prairies in the northeastern part of the State. From these points they have gradually spread southward, extending their breeding range as far south as the counties of Union, Decatur, Marion and Vigo. They are not numerous there; but under favorable conditions, a few may be found at nesting time, enlivening the scenes of rural life with their charming songs, as far south as has been indicated (Butler, Proc. I. A. S., 1896). The Prairie Horned Larks, too, from practically the same districts, have gradually been found to nest farther south until they have been reported as breeding in Franklin, Decatur, Johnson, Monroe and Knox counties. Following their extension southward, their numbers have gradually increased until now they are familiar birds in many places where they were unknown a few years ago (Butler, Birds of Ind., 1897, pp. 874-6).

As tillable land is neglected and begins to grow up in bushes and briers, other birds press in to occupy such congenial haunts. The most notable of these, perhaps, are Bachman's Sparrow (Peucæa æstivalis bachmanii), the Lark Sparrow (Chondestes grammacus), the Cardinal or common Redbird (Cardinalis cardinalis) and the Yellow-breasted Chat (Icteria virens). All these have been observed to be extending their range, where conditions are favorable; but the extension, perhaps, is the most striking in the case of the two sparrows first mentioned.

From the south other forms are ranging into our limits. The Black Vulture (Catharista atrata) was found by Audubon in southern Indiana. From 1834 to 1879, it was not reported from the Ohio Valley. It was next noted in Indiana in 1879 (Quick. J. C. S. N. H. 1881. p. 341). It is now recognized as a resident in some numbers in the lower Wabash and Whitewater valleys, and is found in regularly increasing numbers in the southern third of the State. Bewick's Wren (Thryothorus bewickii) is slowly spreading over the same district (Trans. Ind. Hort. Soc. 189. p. 99). It soon becomes acquainted with man and takes up its abode about his home. In that region, it becomes the House Wren, replacing the larger Carolina Wren (Thryothorus ludovicianus) which has, latterly, to a great extent, left the vicinity of man's structures and inhabits the thickets and the underbrush of the more open woods. These are not to be confused with the smaller Short-tailed Wren, the true House Wren (Troglodytes ædon), that breeds in central and northern Indiana. Other birds, also, have changed their habits. The Purple Martin (Progne subis), Barn Swallow (Chelidon erythrogaster) and Phœbe (Sayornis phœbe) have generally sought after other breeding sites than the cliffs and bluffs where the white men first found their nests. The Chimney Swift (Chætura pelagica) now prefers an unused chimney to a hollow tree. We have become so accustomed to these sociable birds that it is hard to realize that they have not always been dwellers with man about his home. Some of them, most notably the Eave Swallow (Petrochelidon lunifrons) and the Purple Martin, have been the birds most persecuted by the European House Sparrow (Passer domesticus), generally called "English Sparrow." They have made use of the nests of the former; have occupied the sites of the latter. The result is that comparatively few of either of these birds are left with us.

INFLUENCE OF RIVERS.

The rivers of Indiana penetrate the State from different directions, and each has its influence, be it greater or less, upon the distribution of life. The most prominent streams are the Wabash and its tributaries, and the Whitewater and Kankakee. Lake Michigan touches our limits; and its effect is likewise felt. The extension southward into the upland meadows, between the water courses, of the birds of the open prairies, and the

range of southern forms up the valleys of our streams is as though the great spread fingers of two mighty hands were interlocked, the one representing the extension of life southward and the other the projection of southern birds northward.

The region of the Lower Wabash, with its bottoms, cypress swamps and ponds, was the home of many southern birds which found there the northern limit of their range. Among these congenial surroundings were noted such southern forms as the White Ibis (Guara alba), Wood Ibis (Tantalus loculator), Yellow-crowned Night Heron (Nyeticorax violaceus), Little Blue Heron (Ardea cærulea), Snowy Heron (Ardea candidiesima), American Egret (Ardea egretta) and Florida Cormorant (Phalacrocorax dilophus floridanus). Some of these there made their homes and reared their young. Other birds ranged farther up the stream and it, and other water-courses, are now known to be routes along which certain species move to breeding grounds farther north.

The extreme effect of a river on the distribution of a bird is illustrated in the case of the Prothonotary Warbler. Prior to 1875, it was regarded as solely a bird of the Southern States, yet its actual range was then, without doubt, practically the same as we now know it. In that year Mr. E. W. Nelson observed it to be common in the Lower Wabash Valley in Illinois (Bull. Essex Inst. Vol. IX, 1877. p. 34). In 1878, Mr. William Brewster found it abundant in Knox and Gibson counties, Indiana (Bull. Nutt. Orn. Club, Vol. III, 1878. p. 155). The natural haunts of these birds are the swampy woods and the thickets along water-courses or about ponds or lakes. As one suitable locality after another was discovered farther northward, it was found to be occupied by these birds. They were reported from Vigo, Clinton and Carroll counties and from just over the State line near Danville, Illinois. They extended up the Mississippi River, sending off numbers of migrants up the different river courses. Some ascended the Kaskaskia and others the Illinois (Loucks Bull. Ill. Lab. N. H., Vol. IV, 1894). The Kankakee, a tributary of the latter stream, comes into northwest Indiana from the west and becomes quite a factor in its influence upon bird life. At Momence, Illinois, its course is blocked by an outcrop of stone. Above this, it is a sluggish stream, at times widening into lakes. Much of its course is bordered by woods. Marshes and swamps alternate with thickets and sloughs along its valley. Amid such attractive surroundings, Prothonotary Warblers find summer quarters and are characteristic birds. They likely reach

this valley by way of the Illinois River, though possibly some may come from the Wabash Valley. The divide between the Kankakee Basin and the Lake Michigan Basin is but a slight barrier. Occasionally, these birds are found near the Lake Shore in Lake and Laporte counties, and at places along the St. Joseph River and its tributaries, both in Michigan and Indiana (Cook. Birds of Mich. 1893. p. 110). In St. Joseph County, Michigan, and the counties of Elkhart, Lagrange, Steuben, and in the adjoining county of Dekalb, in this State, they have been found, at some places, breeding commonly. The Prothonotary Warbler has never been reported along the Ohio River above the mouth of the Wabash.

The Sycamore Warbler (Dendroica dominica albilora) is another bird that prefers the vicinity of streams and in its migration follows their courses. It is found not only along the Wabash River, but also along the Ohio and Whitewater. It is common up the Wabash River to Carroll County and has been noted from Lafayette and Ft. Wayne. There is nothing to show that it is found in the Kankakee Valley or reaches the basin of Lake Michigan. It is common up the White River Valley, as far as Indianapolis, and up the Whitewater River to Brookville, ranging to Connersville and Richmond. By one of these routes, it pushes on to southeastern Michigan. There, is has been found in some numbers in the valley of the Raisin River, Monroe County, in Kalamazoo County, and has been reported as not uncommon near Detroit.

The Cerulean Warbler (Dendroica rara) is not a bird living solely along the streams, but appears to prefer the wooded sides of the valleys. It extends its range up the Wabash River to Carroll, Tippecanoe and Wabash counties. It has been found at English Lake near Kouts in the Kankakee Valley. It ranges up the Whitewater River to its upper waters; is found about Muncie; is tolerably common in Dekalb County; and is one of the most common woodland birds in Monroe, Wayne and Ingham counties, Michigan. These localities are probably reached by way of the Whitewater or Miami river. It, like both the Warblers previously referred to, breeds in suitable places throughout its range. Each of these three species frequents different kinds of localities; the Prothonotary Warbler, as noted, prefers the wooded swamps; the Sycamore Warbler seeks the tall timber along the streams, preferably, as its name indicates, the sycamore trees; the Cerulean Warbler occupies the woods of the river valleys, but appears to prefer the wooded hillsides that

border them. Each is notably affected in distribution by the watercourses.

EFFECT OF LAKE MICHIGAN.

The effect of a large interior body of water is well illustrated by Lake Michigan. There, on the open water, many kinds of water fowl, that would otherwise go south, remain through the winter. To it, come different forms of sea birds in spring, winter and fall. Among these are Jægers, the rarer Gulls and some Sea Ducks.

It also attracts such cosmopolitan birds as the Knot (Tringa canutus), Turnstone (Arenaria interpres) and Sanderling (Calidris arenaria). The latter and the Semi-palmated Plover (Ægialitis semipalmata) are found along its shores in considerable numbers in late summer. The Belted Piping Plover (Ægialitis meloda circumcincta), a bird supposed to breed much farther northward, has been found breeding along the pebbly lake beach. The effect of the lake upon the local climate has been observed by farmers. The result is noticeable in the fruiting of plants. Fringing the southern shores of Lake Michigan are sandhills or dunes of varying sizes, some reaching an altitude of more than 150 feet. Upon and near these, grow northern pines and other characteristic vegetation. As would be expected, birds that love homes among the pines are to be found. While comparatively little study has been given to this region, it is known that the Pine Warbler (Dendroica vigorsii) breeds there (Brayton. Proc. Ind. Hort. Soc. 1879. p. 108). Other northern forms have been reported, and it is likely careful investigation will show other interesting facts concerning this district. Wherever pines grow, the American Crossbills (Loxia curvirostra minor) seem to be more or less regularly found. This is not only true among the sand-dunes near Lake Michigan, but about Lafayette, Bloomington and Brookville. At each of the two first named places, they have been reported as breeding. While this would not be surprising the reports have not been verified. The pines in other restricted areas, notably Pine Hills, Montgomery County, and the Knobs in southern Indiana, are interesting fields for the study of these points.

The most notable influence in the bird-life of our State is the changes that have been wrought through man's influence. The general condi-

tions of migration, breeding and food supply are those common to all regions. They operated in the days of the aborigines as they do this year, differing only in some of their manifestations. The unusual conditions, such as storms, effecting the dispersal of birds, work now as hitherto. There are special conditions manifested in favorable surroundings, attractive bird-homes, and in topographical encouragement, leading them to extend their range. These are strongly illustrated in this State. To him who carefully studies the birds of any locality, these powerful influences are apparent. They are emphasized by their details and their repetition. By grouping the results of local observations, is told the story of the influences acting in the distribution of the birds of the State.

Discoid Pith in Woody Plants.

By F. W. Foxworthy.

The occurrence of a discoid pith, i. e., one which is interrupted at frequent intervals by cross partitions variously known as disks, diaphragms, plates or lamellæ, has been noted by numerous observers in certain of the woody plants.

The first mention of it seems to have been by the Anatomist Grew (Anat. Plantarum, 1682. Pl. 19, f. 4), who described and figured it in *Juglans*.

Ch. Morren, in the Ann. Nat. Hist., Vol. 4, No. 22, 1839, gave a good historical sketch of the observed cases of discoid pith, and described in detail and figured certain forms.

W. C. Williamson (Proc. Man. Lit. and Phil. Soc. for 1851) in a paper "On the Structure and affinities of the plants hitherto known as Sternbergiæ"—described the casts of this kind of pith which had been considered entire fossil plants—with the group name *Sternbergiæ*, and showed their true nature and affinities—as members of the genus *Dadoxylon Brongn.* He also mentioned the occurrence of discoid pith in a number of recent plants.

M. Gris, in his very painstaking work "Sur la moelle les plantes ligneuses" (Ann. des Sci. Nat. ser. 5, No. 14, 1872), described two structurally distinct forms of discoid pith. The first, which he terms *Heterogenous Continuous Diaphragmatic*, has the pith continuous between the disks, e. g. *Liriodendron*.

The second he terms *Heterogenous Discontinuous Diaphragmatic* and, in this, the pith is not continuous between the disks, the interspaces being empty or filled with air, e. g. *Juglans*.

Pith of the first type occurs in *Liriodendron* and *Magnolia species*, in *Asimina* and some other representatives of the *Anonaceæ*, in *Nyssa*, and, according to Solereder (Anatomie der Dicotyledonen, Stuttgart, 1899), in many of the *Ternstroemiaceæ*, as well as in *Brachynema* (*Ebenaceæ*) and in certain of the *Convolvulaceæ*.

The cells making up these disks are large, irregular in outline, very thick-walled, lignified, and contain starch in winter. The cells filling the interspaces are small, regular, very thin-walled, unlignified and empty.

The formation of the disks takes place at a very early stage in the growth of the twig; they may be seen just back of the growing point in Fig. 1, which is a longitudinal section through a young twig of *Liriodendron*.

The genus *Magnolia* presents some interesting modifications of this type. The genus has been described as always having these partitions in the pith; but, several have pointed out that this statement is incorrect. In the examination of the American and some of the Asiatic species, I have found only two, *M. Virginiana* and *M. fœtida*, in which the fully developed disks occurred. In all the other species examined, cells of the sort described as making up the disks occurred scattered singly or in small groups throughout the pith. Baillon, in his Natural History of Plants, says of this: "In the rapidly developed shoots of some Magnolias we have seen these septa reduced to a single cell, nearly central, on which all the surrounding cells of the ordinary parenchyma abut by one end, bent, or drawn out in a quite peculiar fashion."

In Fig. 2, which is a longitudinal section of a twig of *M. tripetala*, these scattered groups of cells are shown; and, Fig. 3 shows the same kind of cells in a cross-section of a twig of the same species.

In *Asimina* the disks seem to be made up of more regular and thicker-walled cells than are found in *Magnolia* and *Liriodendron*.

In the slender woody twigs of *Nyssa*, very strongly developed disks were found, stronger in fact than in any other case examined.

Function of pith of this type:—

No satisfactory explanation of the function of this type of pith has been offered. From superficial examination, the suggestion that its function was one of mechanical support would seem reasonable; but, the fact that the most strongly developed diaphragms were found in the strong and slender twigs of *Nyssa*, while the thick *Magnolia* twigs with their relatively large pith showed the weakest development of this type, seems to indicate that the suggestion of mechanical support is not a sufficient explanation of their function.

The second type of pith has often been mentioned and figured in species of *Juglans*. I have also studied it in *Pterocarya*, *Celtis*, *Mohrodendron* (*Halesia*), *Forsythia viridissima*, *Jasminum species*, *Paulownia*, and

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4

Actinidia. Besides these, Solereder found it in *Wormia* (*Dilleniaceæ*), *Diplotaxis* (*Cruciferæ*)-*Fouqiera* (*Tamarisc*), *Princepia* (*Chrysobalanaceæ*), *Aucuba* (*Cornaceæ*, only in herbarium material), *Pedalium* (*Pedaliaceæ*), *Daphnyphyllum* (*Daphnyphyllaceæ*): Williamson also found it in the fossil plants known as *Sternbergiæ* and mentions it as occurring in certain living species of *Pinus*. In some genera, as e. g. *Forsythia* and *Jasminum*, it occurs in some species but not in others.

The cells making up the partitions are thin-walled, empty and often shrunken and the space between the partitions is irregular in outline and extent. Fig. 4, from a twig of *Juglans cinerea*, shows this type.

Function and manner of formation:—

Morren and Williamson both considered that the pith served as a mamilla for the bud and, as the nourishment is exhausted from the pith it separates into disks—beginning first in the immediate vicinity of the bud. The cells in the center of the pith become shrunken and the pith separates into layers. This takes place quite early in the growing season. Morren gives good figures of this process in *Juglans regia*. The fact that twigs of *Celtis* often have the pith very plainly discoid in the region of the nodes but solid in the central part of the long internodes lends support to this view.

Taxonomic value of the occurrence of discoid pith:—

Juglans and *Pterocarya* are definitely separated off from the rest of the *Juglandaceæ* (A. Engler in Engler & Prantl-Nat. Pflanz. Fam. III. I. p. 21) by the possession of discoid pith. In *Liriodendron*, *Asimina*, *Nyssa Celtis*, *Mohrodendron*, *Actinidia*, and several others, the presence of discoid pith seems a good generic distinction; but, in certain cases, as, *Forsythia* and *Jasminum*, it is of only specific value.

The New Science Laboratory at Moores Hill College.

By A. J. Bigney.

At the last meeting of the Board of Trustees of Moores Hill College, in June, 1904, they made additional provision for the Science Department by purchasing a large three-story brick building in the town which had been used as a business house. This building is very well adapted to its new purposes. Most of the internal changes have been made and the building occupied except the third story. It is forty-five feet front and seventy feet deep, and three stories high, with a full basement. The basement is used as a furnace room, shop, store-room, and photographic room.

The first floor contains a scientific library, a private room for the instructor, a combined biological laboratory and recitation room, a combined museum and geological laboratory, and one room occupied by the Y. M. C. A. and Y. W. C. A.

The second floor is occupied by the Philonelkean Society as chapter rooms. When the college needs these rooms the Society will vacate them.

The third floor will be occupied by the chemical and physical departments.

The scientific departments now have plenty of room for increasing their efficiency. The museum is growing very rapidly and this building will make it much more serviceable. No movement has been started in recent years that will prove as helpful not only for the college but also for the scientific interests of southeastern Indiana.

The Apache Stick Game.

By Albert B. Reagan.

(Abstract.)

(Original in possession of the Bureau of American Ethnology. Illustrations used by permission of Bureau.)

The Apache stick game is played only by the women. It is played in the winter when there is no farm work to be done; also at any other time when the women are not employed in the daily toil. At this game the women are experts. It is a gambling game, and the women often bet and lose all they have on it, even the clothes on their backs. Most usually, however, only beads and such-like trinkets are staked. Below is a description of the game and the requisites: The game-field, including its rock-circle, the counting sticks, and the three "Setdilth" sticks used in playing the game.

The Game Field.—This field is a level, circular spot, six or seven feet in diameter. This circular area is inclosed in a circle of cobblestones, forty in number. These rocks are arranged in groups of ten each, that is, ten to each quadrant of the circle. The rocks are the tallies; an entire circle of forty tallies constitutes a game. Besides the rocks in the circle, a large flat rock occupies the center of the field. On this rock are hurled the setdilth sticks on their mission of chance, as we shall see later.

The Counting Sticks.—These are small sticks used in marking the tallies gained. One of these is placed between the last rock tally and the next rock in the circle in the direction the player is moving it.

The Setdilth Sticks.—These are three in number. Each is a foot in length and is the half of a green limb or a willow shrub of about an inch in diameter. The bark is left on the round face; its split face is marked by a broad diagonal charcoal mark across the center. These sticks are all held in the hand in a vertical position at the same time, and are hurled endwise upon the center rock to fall with whichever face up chance may direct. Counting the points then begins.

Counting the Points.—The points in the game are decided by the faces of the setdilth sticks that are up after the sticks have fallen. If

one split face is up it counts two points; if two split faces, three points; if all three split faces, five points; and if the three rounded faces are up ten points and the player has the privilege of playing again before passing the sticks to the next player.

MARKING THE POINTS GAINED.—Usually four persons play this game. The opposite players are partners. One set of players move the counting

The Setdilth Game—Sticks falling after having bounced on the center rock.

sticks round the stone-circle in one direction (Each player has her own counting sticks whether a partner of another man or not); and their opponents move in the opposite direction. For the points gained in hurling the sticks an equal number of rocks in the circle are counted and the counting stick is moved forward to the position between the last rock tally and the next cobble-stone in the direction the counting stick is being moved. In moving the counting stick, should it chance to be placed in the space between two rocks that an opponent's counting stick is occupying, the

opponent's counting stick, that is, the first stick occupying the space is taken up and its owner must begin the game again. Two skilled players will often throw each other back in this manner time after time. This makes the game quite interesting. When a counting stick has completed the entire circle, that is, when it has marked forty successive tallies its owner has the game. A transfer of the staked property follows. Then the betting begins for a new game.

A Note on the Radio-Activity of Strontium Salicylate.

By J. F. Woolsey.

(By title.)

Cuban Notes.

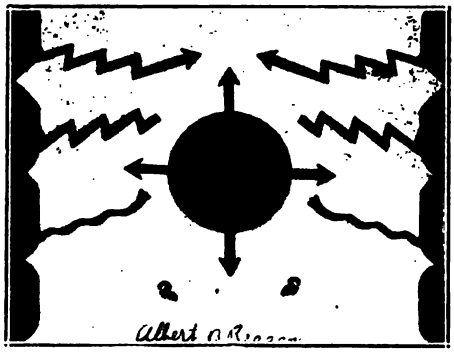
By C. H. Eigenmann.

(By title.)

Some Paintings from One of the Estufas in the Indian Village of Jemez, N. M.

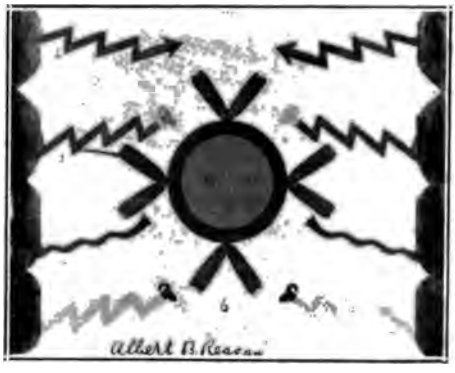
Albert B. Reagan.

Soon after I became U. S. Indian Farmer at Jamez, N. M., the Jamez Indians had a masked dance, and as this dance occurred on mail day they stopped the mail carrier and would not allow him to proceed on his journey. This they did in accordance with their custom not to allow a white man to enter or to pass through the village while they were thus occupied. The stopping of the mail led to the arrest of the Indian Governor, Jose Romero, who, as a result of the preliminary examination, was bound over to the United States grand jury which was to meet the next March, six months after the crime was committed. Taking pity on the Indian, I bailed him out, and took him back to the village. From that time on throughout the winter months the Jamez were very friendly to me and allowed me to visit their performances at will, though they did not send me special invitations to do so. At the trial in March the governor was found guilty and fined the full extent of the law for interfering with the carrying of the mail. As soon as the sentence was handed down, I went to the judge, and after a great deal of argument, persuaded him to suspend the sentence upon the promise of good behavior. So I returned to the village with the governor a second time. In the evening after our return the "Principals" of the place met, and as the greatest favor they could bestow upon me they invited me in the name of their tribe to visit any and all of their ceremonies, both open and secret, stating further that they would let me know whenever they had any special ceremony. This, with but one exception, they carried out to the letter. Acting upon this invitation I visited each of the Estufas at will, often being with the Indians in them sometimes as high as six nights in a week. I also examined the "blind closets" and secret rooms in the dwellings. Thus was I enabled to see many things of interest. Among these are the masks worn by the clown dancers in the masked dance, and the paintings on the inside walls of the Estufas and of the secret rooms. Some of these are here given.



I. Sun-God Section in One of the Estufas at Jemez, N. M.

1. Clouds, the Steps to Heaven. (Dark marginal figures.)
2. The Bolt Lightning that does not strike the earth. (Upper figures.)
3. The Bolt Lightning that strikes the earth. It is the Red Snake or Indian Devil, called Savah by them. (Second figure from the top on each side.)
4. The Flash Lightning, the God of Flowers. (Third figure from top.)
5. The Good Snake, the Blue Snake, the God of Rain. (Lower figures.)
6. The Sun, the father of the universe and the God of all things. By the Indians he is called Patahgatzah or Pay.



II. The Moon-God Section in one of the Estufas at Jemez, N. M.

1. Clouds.
2. Bolt Lightning that does not strike the earth.
3. The Red Snake or Indian Devil.
4. The Flash Lightning, the God of Flowers.
5. The Blue Snake, the God of Rain.
6. The Moon, the Mother God of the Universe, called by the Indians Ahtahwahtzah, or Pah.

IV. The Evening Star Section in one of the Estufas at Jemez, N. M.

1. Clouds.
2. Bolt Lightning that does not strike the ground.
3. The Red Snake or Indian Devil.
4. The Flash Lightning or God of Flowers.
5. The Blue Snake, the God of Rain.
6. The Evening Star, the God of the Evening. Jointly with its brother, the Morning Star, it possesses the attributes of Truth and Filial Love. Its Indian name is Homa Wangho.

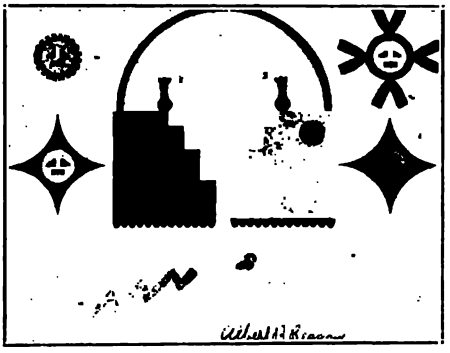
Note.—The photographer having spoiled the negative of the Morning Star Section, I cannot show a photograph of it here.

VI. A Rainbow Section in One of the Estufas at Jemez, N. M.

1. Clouds.
2. The Bolt Lightning that does not strike the ground.
3. The Bolt Lightning that strikes the earth. It is the Red Snake or Indian Devil.
4. The Flash Lightning, believed by the Indians to be the producer of bloom, hence the God of Flowers.
5. The Blue Snake, the God of Rain.
6. The Rainbow in the East. (a) Water receptacles of the universe; (b) Clouds, the Steps to Heaven; (c) raindrops; (d) the rainbow arch; (e) dart-heads thrust out by the rainbow as a means of protection.

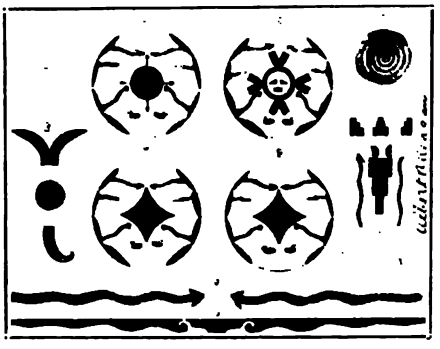
Note.—This is the rainbow in the east. Beneath the arch the representatives of good and evil, the rain snake and the red snake, are in combat. The rain snake, being defeated, is retreating eastward and is taking the clouds with him, hence the rain is over.*

*The Rainbow Section just opposite this section represents the rainbow in the west. It differs from the rainbow section given here in that it has the God of Flowers projecting from the water jars beneath the arch.



VII. A Wall Painting in a Secret Dark Room in One of the Indian Houses at Jemez, N. M.

1. Sun. (In left-hand upper corner.)
2. Moon. (In right-hand upper corner.)
3. Morning Star.
4. Evening Star.
5. Rainbow in the West.
6. The Red Snake.
7. The Blue Snake, the God of Rain.
8. The Flash Lightning, the God of Flowers. It is projecting from the water recep tacles of the universe. The step-like figures below the water-jars are clouds from which raindrops, represented by black points, are dropping.



VIII. A Miscellaneous Group.

1. The Sun as carved on a bowlder on the trail between Zia and Jemez, N. M.; also on a rock near White River, Ariz.
2. A Sun drawing in an Estufa at Santa Anna, N. M.
3. A Getlu, probably a representation of a comet. It was used as a handpiece in the masked dance of March 17, 1900. (Used here by permission of the Bureau of American Ethnology.)
4. A Head Ornament worn by a male column dancer in the masked dances at Jemez, N. M.
5. A Sun Mask worn by a sun clown in the masked dances at Jemez.
6. A Moon Mask worn by a moon clown in the masked dances at Jemez.
7. A Morning Star Mask worn by a morning star clown in the masked dances at Jemez.
8. An Evening Star Mask worn by an evening star clown in the masked dances at Jemez.
9. The Bolt Lightning drawn on the beam at the entrance of an Estufa at Santa Anna, N. M.
10. The White Snakes drawn on the center beam in the south Estufa at Jemez, N. M.

Geology of Monroe County, Indiana, North of the Latitude of Bloomington.

By Albert B. Reagan.

This work was undertaken as independent research work in stratigraphic geology in Indiana University, in the summer of 1903, at the suggestion of Dr. J. W. Beede.

In 1880 Mr. G. K. Green published a paper entitled "Geology of Monroe County,"* in which he discusses the stratigraphy of the county, giving several sections and lists of fossils and a very generalized geological map of the county. Mr. C. E. Siebenthal has given a lengthy description of a considerable part of the the region here under consideration in his report on the "Bedford Oölitic Limestone."** Prof. V. F. Marsters describes the geography of Bean Blossom Creek in an article entitled "Topography and Geography of Bean Blossom Valley, Monroe County, Indiana."*** These papers will be discussed when the subjects with which they deal are taken up.

GENERAL REMARKS.

The rocks of this region, with the exception of the Glacial and post-glacial, are Mississippian in age. At the close of the Mississippian period or in the later Carboniferous time the region was raised above the sea. With the exception of a few cases due to local warping its strata dip gently to the southwest. After the area was elevated, the erosive agencies thoroughly dissected the region. The master stream, Bean Blossom Creek, and its numerous tributaries incised for themselves canyon-like valleys. Then on reaching grade, they widened their inner valley floors. On these floors the streams meandered, until a glacier, which crossed the northern part of the county, dammed the lower Bean Blossom and laked the region. Since the retreat of the glacier, side tributaries have, for the most part, recut their channels through the glacial debris to their former level; and

*2d Ann. Rep. Bureau Statistics and Geology, Indiana, pp. 427-449, 1880.
**21st Ann. Rep. Geol. Nat. Res. Ind. pp. 293.
***Proc. Ind. Acad. Sci. 1902 (for 1901), pp. 222-237.

Bean Blossom is now aggrading its channel. The region thus dissected by stream-cutting presents an intricate mass of small, deep canyon-like valleys separated by sharp ridges.

STRUCTURE.

The Mississippian rocks of northern Monroe County are divided into the following formations beginning at the top; Mitchell limestone, Salem (Bedford) limestone, Harrodsburg limestone and the Knobstone (the latter including the Riverside sandstone and the New Providence shales). These formations are exposed in the order named as one passes across the county from west to east. The dip is to the south of west.

SECTIONS.*

Section 1.—From Stout's Creek east to the top of the divide on the half section line of Section 8, Bloomington Township:

Harrodsburg limestone—

		Feet.
1.	Unseen	20
2.	Thin-bedded limestone	15
3.	Very thin-bedded, gray limestone (crinoid stems abundant)	5
4.	Thin-bedded limestone	10
5.	Massive limestone forming base of cliff	20

Knobstone—

6.	Massive sandstone	20
7.	Shaly sandstone and sandy shale	32
8.	Unseen	25
	Total	147

Section 2—On small creek near northwest corner of northeast ¼ Section 7, Bloomington Township:

Oölitic—

		Feet.
1.	Unexposed	70

Harrodsburg limestone—

2.	Thin-bedded limestone (Spirifer)	2
3.	Unseen	12

*The strata of the sections are numbered from the top downward.

		Feet.
4.	Dark, irregular, non-fossiliferous limestone weathering rough. (There are rusty particles in this stone which forms the falls in the stream.)	10
5.	Limestone	4
6.	Rather massive, dark, iron-gray limestone forming second fall	2

Knobstone—

7.	Very hard, thin-bedded, light-colored sandstone	4
8.	Massive, hard sandstone	4
9.	Thin-bedded limestone grading into massive sandstone. Forms third fall	25
10.	Unseen. Sandstone?	5
11.	Sandstone	5
12.	Massive, thin-bedded, soft, light-colored sandstone	20
13.	Light-colored sandstone weathering to yellow and brown	10
14.	Shaly sandstone and sandy shale	20
15.	Unseen	20
	Total	213

Section 3—On the west line of Section 5, Bloomington Township, near southwest corner:

Knobstone--

		Feet.	*Inches.*
1.	Massive sandstone with reddish-brown bands	4	0
2.	Laminated white sandstone with reddish-brown bands	5	0
3.	Massive light-colored sandstone	2	0
4.	Laminated soft, brown sandstone with reddish-brown bands	0	8
5.	Shaly sandstone	9	4
6.	Massive, rather soft, light-colored sandstone. Weathered surface dirty brown, rough, pitted	10	0
	Total	31	0

Section 4—Near the northwest corner of the southeast ¼ of the northeast ¼ of Section 25, Bloomington Township:

Harrodsburg limestone—

		Feet.	*Inches*
1.	Light to dark gray limestone	5	0
2.	Very thin-bedded, rough, non-fossiliferous limestone	12	0
3.	Unseen. Limestone?	10	0
4.	Dark gray limestone weathering rough and pitted. Very fossiliferous	0	2
5.	Thin-bedded limestone, gray in color and weathering a pitted surface	5	0
6.	Laminated, thin-bedded, fine-grained, gray limestone	0	6
7.	Unseen	5	0
8.	Thin-bedded, course, iron-gray limestone weathering rough. Forms an escarpment	10	0

Knobstone—

9.	Sandstone	40	0
	Total	87	8

Section 5—Just east of Andrew Stine's residence, one and one-half miles east of Stinesville.

Glacial—

		Feet.	*Inches.*
1.	Unseen	2	0
2.	Cross-bedded brown sand, indurated at the top	12	0
3.	Unseen	5	0
4.	Very finely laminated, yellow sand, banded with brown	0	4
5.	Closely compacted gravel composed mostly of angular fragments, many of which are foreign to the region	1	0
6.	Irregularly stratified sand (moulding)	5	0
7.	Unconsolidated, light-brown sand	25	0
8.	Reddish-brown sandy clay	5	0

Harrodsburg limestone—

9.	Limestone forming precipice in ravine	0	4
10.	Very hard, thin-bedded, dark-gray sandstone	5	0
11.	Very hard, bluish-gray sandstone	15	0

		Feet	Inches.
12.	Thinly-bedded gray sandstone, banded with streaks of white	0	4
13.	Thin-bedded, light-colored sandstone	10	0
14.	Sandstone	35	0
15.	Unseen	20	0
	Total	140	8

The sand represented in the upper part of this section was deposited at the foot of the glacier. The mouth of the little stream was closed by the ice and its basin laked, allowing the deposit of the stratified material. The stream has since cut a gorge through the center of the deposit. The lateral extent of the deposit is not great because the little lake was small and narrow.

Section 6—In railroad cut 1 mile north of Stinesville:

Thicknesses, in part, estimated.

Harrodsburg limestone—

		Feet.	Inches.
1.	Massive to thin-bedded limestone	40	0

Knobstone—

2.	Very hard, rough-feeling, granular, calcareous sandstone weathering to a rusty brown	0	3
3.	Bluish-gray, massive sandstone	3	0
4.	Bluish-gray sandstone filled with chert and geodes	0	8
5.	Soft, blue sandstone	0	3
6.	Calcareous, fossiliferous, somewhat cherty sandstone	0	6
7.	Bluish-gray, very soft shale	0	8
8.	Thin-bedded, soft, very light-brown sandstone	2	0
9.	Stratum of chert concretions	0	4
10.	Massive, brown sandstone weathering dark and pitted	6	0
	Total	53	8

Section 7.- On the road an eighth of a mile west of Bowman Schoolhouse, Bean Blossom Township:

Glacial

		Feet.	Inches.
1.	Yellowish, jointy clay with small rock fragments and occasional bands of brown moulding sand one to six inches thick	12	0
2.	Very light-brown sand, when wet (white when dry), and extremely fine	40	0

Section 8.—On the road west of the Able Schoolhouse, just east of Mr. Maple's residence, Bean Blossom Township:

Glacial material--

		Feet.
1.	Yellow clay grading into moulding sand	15
2.	Light-colored clayey sand	10
3.	Yellow sand	10
4.	Light-colored sand with occasional bands of gravel and a few bowlders	55
5.	Yellow clayey sand	4
6.	Gravel	3

Knobstone—

7.	Sandstone	2
	Total	99

Section 9.—Township line, ¾-mile north of Lemon P. O.

A section in delta deposit. Glacial—

		Feet.
1.	Yellow clay	3
2.	Thinly-bedded, finely-stratified, yellow to light-brown clay breaking down to a hard yellowish-brown clayey earth	3
3.	Yellow, laminated, extremely fine moulding sand, banded with bands of yellow, brown and white indurated material	10
	Total	16

Section 10.—North and south section line, 420 yards west of Lemon P. O., on the south side of the ridge.

Harrodsburg limestone—

		Feet.	*Inches*
1.	Thin bedded, bluish-yellow limestone	5	0
2.	Thin-bedded, gray to brown limestone, poor in fossils and weathering pitted	20	0
3.	Brown to gray, rather hard limestone, composed of crinoid stems and Bryozoa	5	0
4.	Yellow, non-fossiliferous limestone with rusty particles	0	6
5.	Blue-gray limestone weathering yellow and brown	5	0
6.	Very hard, speckled limestone	0	6
7.	Very hard, rough, gray limestone, composed largely of crinoid stems	2	0
8.	Yellowish-blue limestone	1	0
9.	Massive, hard, fossiliferous limestone	4	0
10.	Limestone	10	0
11.	Thin-bedded, very hard, fossiliferous limestone (crinoids and Bryozoa)	1	0

Knobstone—

12.	Sandstone	45	0
13.	Unseen	30	0
		—	—
	Total	129	0

Section 11.—Near Mr. C. C. Fulford's home on Indian Creek, half a mile west of Canada Gap:

Knobstone. Thickness estimated—

		Feet.
1.	Sandstone grading into coarse shales	100
2.	Bluish-gray, very soft shale	25
	Total	125

Section 12.—Up ravine near the northeast corner of northwest ¼ of Section 3, Bean Blossom Township, near Mr. Samuel Kid's residence:

Harrodsburg limestone—

	Feet.
1. Massive, white to gray, hard limestone with many geodes	15
2. Thin-bedded, very fossiliferous, iron-gray limestone (Bellerophon, Productus and Spirifer.)	4

Knobstone—

3. Thin-bedded, rusty sandstone with geodes	4
4. Massive, bluish sandstone	3
5. Thin-bedded, blue sandstone	3
6. Massive, bluish-gray sandstone	5
7. Very thin-bedded, shaly sandstone, weathering to white sandy clay	20
8. Thin-bedded sandstone	35
9. Massive sandstone	10
Total	99

Section 13.—Ellet's Hill, ¾ mile west of Lemon Schoolhouse, south of the west side of Ellet's graveyard.

Oölite—

	Feet.
1. Fine-grained, whitish-gray, oölite, like that quarried at Stinesville and Bedford	25
2. Massive, coarse-grained, dark-gray oölite	10

Harrodsburg limestone—

3. Limestone	65

Knobstone—

4. Sandstone and sandy shale	100
Total	200

Section 14.—In ravine north of Mrs. W. E. Wood's house near the center of the north line of the south east ¼ Section 32, Washington Township:

Harrodsburg limestone—

1. Mostly thin-bedded, very hard, steel-gray limestone with crinoid stems	10

Knobstone—

		Feet.
2.	Soft, brown, massive sandstone	10
3.	Thin-bedded, bluish-gray, soft sandstone shaling on weathering	45
4.	Shale	20
5.	Unexposed	10
6.	Yellowish-brown sandstone	5
7.	Not exposed	10
8.	Thin-bedded, yellowish-brown sandstone	2
9.	Covered	15
	Total	127

Section 15.—45 rods west of township line on Hindostan road near Mr. T. J. Farr's house:

Harrodsburg limestone—

		Feet.
1.	Hard, rough, dark-gray limestone containing fossils	15
2.	Covered slope	5
3.	Hard, gray limestone weathering rough, dark, and pitted	5
4.	Thin-bedded, hard, cherty, fossiliferous limestone	10

Knobstone—

5.	Sandstone	4
	Total	39

Section 16.—Ravine west of road, one-half mile south of Bean Blossom Church, north of Unionville:

		Feet.
1.	Oölitic limestone	
2.	Very hard, thin-bedded, light-gray limestone, weathering rough and pitted. Contains fossils	20

Knobstone—

3.	Sandstone, varying from shaly to massive, very soft, blue, weathering yellow and brown	90
4.	Covered slope	10

Stobo limestone, lens—

		Feet.
5.	Hard, rough, gray, crinoidal limestone	1
6.	Hard, gray limestone, few fossils	15
7.	Hard, gray limestone with rusty particles and crinoid stems	5
8.	Soft, blue, sandy shale	10+
	Total	151

STRATIGRAPHY.

The Knobstone is the surface rock over the greater part of the region here considered. It extends from Brown County west to the Harrodsburg limestone contact which extends in a general northwest and southeast direction, crossing the country east of Bloomington. Northeast of this line, however, there are several detached patches of limestone resting on the Knobstone. The entire thickness of the Knobstone is not exposed in this area; but according to Mr. Siebenthal it is about 600 feet. The formation, as far as examined, is composed of a series of alternating, friable, arenaceous shales and sandstones. On the whole the formation is non-fossiliferous. At intervals, however, as at Stobo Post Office, there are intercalated, lenticular beds of limestone and calcareous septaria with rich faunas. This formation, on account of its incoherent, loosely-cemented, easily-eroded condition, has been cut up into a confused tangle of crooked ridges and deep hollows which trend in all directions. Commercially the Knobstone is of little value on account of its friable condition, but the arenaceous shales may be of value in the making of brick and cement.

The Harrodsburg limestone lies on the Knobstone and below the Salem (Bedford) limestone. In the main, it forms a belt from three to five miles in width along the eastern outcrop of the Salem limestone or oölite, and is bordered on the east by the broken hills of the Knobstone. This limestone once covered the entire region east of the oölitic contact, as is attested by its patchy remains in various parts of the county. The triangle between Bean Blossom Creek and White River from Mt. Tabor east to within one mile of Canada Gap is capped with it. A large, irregular, much lobed area of it occurs as the surface rock in the vicinity of the Farr

schoolhouse east of Hindostan, and another just west of Hubbard's Gap. East of the railroad, about two miles southeast of Gosport, a small area of this formation is half submerged in glacial sand. Another small triangular area, with strata dipping to the east, lies on the east side of a ridge a mile south of the Bean Blossom Church. Besides the patches mentioned, there are several other small ones of this formation in the area. In addition to these, main lobes extend to the east from the limestone belt for several miles. One of these lobes extends in a linear strip to Unionville. From there it turns back toward the northwest for three miles. This strip is the watershed of the region through which it extends. On the limestone lobes are located most of the roads in the Knobstone region. The Harrodsburg limestone as exposed on Ellet's hill is 65 feet thick. Its lower portions are limestones containing a great number of geodes, or "mutton heads," which range in size from a pea to a bowlder two feet in diameter. Above the geode layers the stone contains pyrite, is somewhat crystalline, and is tinted with blue, gray, or green.

This limestone is thin-bedded. The bedding planes separating the strata are, in many instances, lenticular, intercalated masses of chert. The strata were found to be more massive toward the top of the formation. Also as the top of the formation is approached the limestone gives up its molluscan fauna and takes on a Byrozoan fauna.

"The contact of the Harrodsburg and oölitic limestones is almost always marked by a 'crowfoot' (stylolite), with which are associated masses of silicified oölitic fossils and black siliceous masses."*

To the present time the Harrodsburg limestone has proved of commercial value only for macadamizing purposes.

The Salem limestone lies above the Harrodsburg limestone and beneath the Mitchell limestone. It forms a belt about three miles in width. It begins near Gosport and extends beyond Bloomington, embracing the quarry districts of Big Creek, Stinesville, Elletsville and Bloomington. Beside the belt strip there are several detached areas. One caps Ellet's hill, near Lemon Post Office. This latter patch covers an area of about ten acres. The oölite of this patch is of average thickness and is of fair quality. It is massive, free from lamination and bedding planes.

*Siebenthal, loc. cit. p. 298.

Analyses of Salem limestone:

Sample 1 from Adams quarry--

	Feet.
Residue insoluble in acid	.41
Lime (CaO)	52.76
Magnesia (MgO)	1.04
Carbon dioxide (CO_2)	43.80
Alumina and ferric oxide (Al_2O_3, Fe_2O_3)	1.57
SO_3	.06
Total	99.67

Sample 2. Johnson quarry, Bloomington--

	Feet.
Residue insoluble in acid	.77
Lime (CaO)	54.67
Magnesia (MgO)	.60
Carbon dioxide (CO_2)	43.04
Alumina and ferric oxide (Al_2O_3, Fe_2O_3)	.42
Phosphorus peroxide (P_2O_5)	.19
SO_3	.19
Total	99.88

For exhaustive treatment of the Salem (Bedford) limestone the reader is referred to Siebenthal's article already mentioned.

THE GLACIAL DEPOSITS.

The glacial deposits, so far as the writer's observations extend are: Glacial till, outwash and eolian deposits, bench or terrace deposits and delta deposits.

GLACIAL TILL.

The drift deposit was first observed on Jack's Defeat Creek in the neighborhood of the old Dutch church. From there it continues in a northeasterly direction, crossing Bean Blossom Creek near the mouth of Camden Branch. According to Siebenthal's description* it then bends south of Lost Ridge, near the mouth of Indian Creek, and follows the course

*21st Geol. Rep Ind. p. 300.

of the latter creek to Canada Gap, continuing in the same direction and, passing a half mile south of Godsey Post Office, it crosses into Morgan County three-quarters of a mile east of Godsey. Swinging southeastward it re-enters Monroe County where Hacker's Creek leaves it, extending up that creek to the neighborhood of Hacker's schoolhouse. From here eastward the drift limit becomes harder to trace. The ice-sheet must have been very thin, since the topography shows little, if any, modification. Scattered erratics are found all over the ridge dividing the waters of Roberts' Creek from the headwaters of Honey and Hacker's creeks. It seems probable that the foot of the ice-sheet rested on this hill, and that the drift found in the head waters of Honey Creek was carried there by the water resulting from the melting of the glacier. Many large granite bowlders from one to three feet in diameter are found along the small stream leading north from Hubbard's Gap, in Sec. 11 (10 N., 1 E.), and along the other tributaries of Roberts' Creek. In section two of the same township heavy deposits of sand, gravel and till lie against the hillsides. In the neighborhood of Godsey Post Office the same phenomena may be seen. Heavy beds of gravel and till lie against the hillsides bordering their slopes on the south. In Canada Gap, section 9 (10 N., 1 W.), the evidences of ice occupation are plain though the quantity of drift material is very limited. The territory between Indian Creek and Bean Blossom Creek and White River displays evidence of ice occupation in many places in modified topography and deposits of till, sand and gravel. Till, sand and gravel occur in the valleys leading south from Hubbard's Gap in the vicinity of Fleener Post Office, and patches of these same materials are occasionally met with south of the divide east of that gap. On the whole the drift is thick in the valleys and thin on the hills. This light drift on the hills indicates that the ice-sheet which crossed them was comparatively thin.

OUT-WASH AND EOLIAN DEPOSITS.

North of Mount Tabor and between there and Gosport, as well as the south slope of the hills between Mount Tabor and Ellet's hill are covered with a heavy deposit of sand. A sand apparently identical with the above caps several hills and fills several preglacial ravines on the south side of Bean Brossom Creek near Andrew Stine's residence about two

miles east of Stinesville. The sand near Andrew Stine's residence was evidently deposited in water. That it was of glacial origin is attested by the fact that it is banded with erratic gravel. The sand here is cross-bedded, stratified and, in several instances, finely laminated. The lamination and stratification, however, are not constant. Towards the top of this sand the stratification ceases. This top seems to have been of eolian origin. This sand was deposited as an out-wash in front of the advancing glacier after it had filled the channel of Bean Blossom. That it was deposited in front of the advancing ice-sheet is clearly shown by evidence that after its deposition the glacier passed over it, crushing it under its weight until now the sand is almost as compact as the Knobstone formation beneath it. Still further evidence that the sand was deposited just in front of the ice-sheet is the fact that the Bean Blossom was filled at that point with ice. Had it been filled with sand instead of ice to the level of the present deposits some remnants of the sand would still remain on the south side of the inner valley of Bean Blossom Creek, which is not the case. The sand in the vicinity of Mt. Tabor and Gosport is very fine and flour-like. It usually forms a loose or slightly compact, massive bed twenty or more feet in thickness. Occasionally it shows indications of stratification, but at no place is the stratification constant. In speaking of this sand Mr. Siebenthal says that it seems to have been deposited from high water resulting from a melting ice sheet.* It is therefore out-wash material. How it came to be deposited as it is, however, is quite a mystery. The deposit is V-shaped with the apex to the west. A limestone ridge separates its legs. On this ridge the sand is thin and suggests by its distribution that it might be eolian in origin. It seems clear, then, that the sand on the south side of the ridge must have come around the west end of the ridge instead of over it, and that the whole deposit was laid down in the slack water between Bean Blossom Creek and White River at the time of the high water that accompanied the melting of the ice-sheet. This opinion is strengthened by the fact that the sand plain gets lower and lower toward the east instead of higher as it would had the sand come over the ridge. This conclusion is further strengthened by the fact that this sand does not occur on the current, or south side of the Bean Blossom as it probably would had it not been deposited in slack water. The sand, on the whole, seems to have been an eddy deposit.

*Op. cit.

BENCH OR TERRACE DEPOSITS.

These deposits have been described both by Mr. Siebenthal and Professor Marsters. In speaking of them Mr. Siebenthal says: "Terraces occur in the valley of Bean Blossom Creek above the crossing of the drift limit. Drift deposits occur below that, but are irregular in height and have not the level top of terraces. The terraces range from mere knolls to benches a mile wide. The lower portions of these beds consist of sand and erratic gravel with sand and smaller gravel above, and over all sandy clay and loam. These terraces seem to have been deposited by high waters which must have resulted from the melting of the glacier which covered the head waters of the creek in Brown County, and the drainage of the glacier which crossed its lower course. The various tributaries of Bean Blossom Creek have similar deposits in a smaller way, the materials of which are, however, of local origin. The fact that the drift material of foreign origin is confined to the creek itself, argues that it was derived from the glacier occupying the upper course of the creek."

In speaking of the same terraces Professor V. F. Marsters says:*

"Rimming the valley slopes are to be found a number of benches of variable widths, with surfaces sometimes as flat as a floor or with an exceedingly gentle decline valleyward, with outer edges lobate in shape and descending with a marked angle to the level of the valley floor. These occur at various points within the limits of Monroe County, invariably situated on the north and east sides of the valley, and varying in elevation from twenty feet in the lower part of the stream to seventy or more feet in the upper part of the valley near the east line of Monroe County. In all the cases examined they were found to be composed of mixtures of clay and sand undoubtedly derived from the disintegrated rock formations constituting the surface of the uplands. No glacial debris of any sort was found either on the surface or in any of the sections or cuts in the benches noted within the limits of Monroe County."

It will be readily seen that the two authors quoted above differ from each other concerning the origin of the bench material. Mr. Siebenthal says in substance, that it is of glacial origin; and Professor Marsters gives a directly opposite view, stating that no glacial material of any

*Proc. Ind. Acad. Sci. for 1901, p. 225.

kind was found in any terrace within the limits of Monroe County. The difference of opinion may be explained in part, by the fact that Mr. Siebenthal has included the delta plains in his terraces and Professor Marsters has omitted them, as is found later in his paper.

To turn to the terraces themselves, the most of them are capped with ten or more feet of a mixture of clay and sand undoubtedly derived from the disintegrated rocks constituting the surface of the uplands. Some of the other benches are capped with glacial material; others with both glacial and residual material. Underneath the loose material are always to be found friable sandstone, or more frequently sandy shales many feet above the water in Bean Blossom Creek. The bench lying between Mt. Tabor and Ellet's hill is composed of shale and shaly sandstone except at the top. The sandstones and shales are exposed at several places along the road leading east from Mt. Tabor as well as in the ravines north of the road. The top is capped by a thin layer of sand or sandy clay. The bench on which Pleasant Valley Church is situated is all shale except the top part which is composed of a few feet of residual clay on which rest ten feet of erratic gravel and clay. The bench on the north side of Bean Blossom Creek, beginning almost one-half mile east of Bean Blossom Church and extending to the Brown County line is composed of blue shale resting upon which are ten to twelve feet of residual clays.

The benches seem to be due not to glacial agencies in the main, but to the bench-weathering of the arenaceous shales of the region, together with the formation of small side deltas which have become confluent. This opinion is strengthened by the following facts: (1) The terraces are higher above the creek bed at the east than at the west, when if they had resulted from a laking of the basin as Mr. Siebenthal supposes they were, they would have been higher at the west. (2) The material did not come from the foot of the glacier in Brown County, as this author supposes, because the finer material is along and just west of the Brown County line, the coarser, farther down the creek. (3) While the benches rise toward the east the deltas of the larger tributaries do not always do so, thus leaving gaps that would have been filled had the bench material come down the creek from the glacier which crossed its upper tributaries. (4) The benches rise toward the east with the rise of the shales.

In preglacial time Bean Blossom Creek, as we shall see later, cut its channel to base level. At that time all its tributaries likewise cut to grade. Both the creek and its tributaries began to meander and to etch back

their valley sides. The thin Harrodsburg limestone being removed as well as the upper Knobstone, the shaly slopes, weathering flat, became, with the modifications mentioned above, the terraces of today.

This subject will be further investigated in the near future. At that time it is hoped that the origin of the terraces can be more definitely determined.

After the ponding of Bean Blossom Creek the tributaries silted up their channels which became miniature estuaries. They then began to form deltas in the lake and in the slack water regions. The western tributaries, for example, Buck Creek, built their deltas in a direct line toward the center of the lake. This demonstrates that the water in which the delta was built was free from strong currents. The deltas of the eastern tributaries swing westward, often forming an east and west bar, now a ridge, thus indicating that these tributaries entered a swollen, westerly-moving stream. The eastern deltas also attest that Bean Blossom Creek was not then ponded but was a slowly moving stream reaching from bluff to bluff. When the estuaries were all filled and the deltas had reached the level of the benches the tributaries spread their debris over the benches as well, so that today it is hard to tell, so far as topographical appearance goes, where the terraces leave off and the deltas begin. Two of the most conspicuous deltas are those of Buck and Wolf creeks. In writing about these Prof. Marsters says:*

"Besides the portion of each creek, wriggling across the valley bottom, there are rather long and narrow strips or delta-like accumulations similar in content to the benches already described, and extending from the valley slope to within a few yards of the Bean Blossom channel which hugs the south slope of its valley. The surface does not attain the characteristic flatness of the rimming benches, but is slightly irregular in relief and increasingly so towards the slope to which it is attached. This is especially true for the Buck Creek case, but not for the Wolf Creek. The increasing irregularity may be in part due to the nearly complete burial of a projecting spur, whose top is barely coated over with the delta deposits now spread almost across the entire width of Bean Blossom; but it must be said that no outcrops of limestone or sandstone, such as make the slopes of the valley, have been discovered within its limits. On the other hand, the irregularity of relief may have been produced by

*Loc. cit. p. 235.

the piling up of the great load of silt within Bean Blossom by the tributary, but did not succeed in building it up to the lake level; in other words, it is an incomplete delta, or bar.

The Wolf Creek case differs from the former only in having a moderately flat top, or at least the higher flats on it attain about the same level, thus suggested that it was built up nearer to water level, and hence more even and uniform in relief. These differ from the rimming benches only in that they *extend across the valley floor*, while the former, being made by smaller streams close to each other, have built a series of small benches or deltas which have become confluent, and hence continuous *along the valley side.*"

The delta material is derived from the disintegrated rocks of the adjacent uplands or is of glacial origin or is of both glacial and residual debris according to the source of the tributary and the proximity of the foot of the ice-sheet. The ice-sheet entered both Canada and Hubbard's gaps and at several places between these two gaps its foot rested on top of the Bean Blossom Creek—White River divide. Consequently glacial material is to be found in the deltas of Indian and Honey creeks leading south from these respective gaps. Below are sections from some of the most conspicuous deltas of the area:

Sections taken on the Buck Creek delta:

Section 1.—Well on Dolan road one mile north of Dolan.

	Feet.
1. Yellow clay	18

Section 2.—Well on Dolan road, one-half mile north of Dolan.

	Feet.
1. Black soil	1
2. White sand	6
3. Yellow clay	15

Section 3.—On A. Oliver's place on the Dolan road one mile north of Dolan. A well was once dug here through yellow clay for 47 feet.

Section 4.—Solomon Laughlin's well about a mile south of Dolan.

	Feet.
1. Clay and sand	36
2. Solid rock	?

Section 5.—On the road on the half section line between sections 34 and 35, Washington township, one and three-fourths miles north of Dolan.

	Feet.
1. Yellow clay breaking down to yellow earth	5
2. Whitish-yellow clay	1
3. Yellow clay	1
4. Whitish, laminated clay becoming very hard on exposure	5
5. Yellow jointed clay	5
6. Yellow to brown jointed clay	5
7. Shale	1+

No glacial material of any sort was found in this delta.

INDIAN CREEK DELTA.

Section 1.—Well at Lemon Post Office.

The section here was composed entirely of loose material. The bottom of the well was in loose erratic gravel at a depth of 20 feet.

Section 2.– Marion Coater's well, forty rods east of Lemon Post Office.

	Feet.	*Inches.*
1. Black earth	2	0
2. Yellow clay	8	0
3. Yellow coarse sand	0	8
4. Gumbo clay	14	0
5. Fine quicksand	3+	

The Indian Creek delta is composed more or less of glacial material, as is shown by the sections. This, of course, was anticipated as the stream heads in Canada Gap.

Sections taken in the vicinity of the Honey Creek delta.

Section 1.—Well north of the road one-eighth of a mile east of Pleasant Valley Church.

	Feet.
1. Clay	5
2. Erratic gravel	7

Section 2.—Another section near the preceding one.

	Feet.
1. Gravel	18
Bowlder stratum	4

Like the Indian Creek delta this delta contains glacial material. The glacial material came through Hubbard's Gap.

A section taken on a delta at the mill south of Dolan gave the following:

	Feet.
1. Bedded, jointed yellow clay banded with red, burns red...	20
2. Bedded, laminated, jointed blue clay, hard when dry, soft when wet	5
3. Very soft, massive, blue clay, burning white.....	20

POST GLACIAL DEPOSITS.

Under this head will be considered the alluvium and the alluvial fan deposits.

Alluvium.

At the close of glacial times Bean Blossom Creek and its tributaries recut their channels to an unknown depth. Then a process of meandering and slight aggrading set in, which has continued to the present time. As a result the creek and its tributaries have developed large alluvial plains. The alluvial plain of Bean Blossom will average a mile in width throughout Monroe County, while many of its branches have bottoms a quarter to a half mile wide in their lower courses. The depth of the alluvial deposits was not ascertained, but in lower Bean Blossom Valley they are probably quite thick. The best farms of the region are located on these plains.

Alluvial Fans.

A number of small V-shaped valleys with very steep channels were found traversing the steepest, southern slopes of Bean Blossom Valley. These on reaching the valley-floor spread out their debris in the form of alluvial fans, their channels disappearing altogether where the fan intercepts the valley floor. The fans project but a few yards beyond the mouths of the valleys. These are evidently fans as they do not possess the flat tops and steep outer margins of the deltas. That they are post-glacial is evident from the fact that some of the little valleys have cut their channels through glacial debris. The one just east of Andrew Stine's house will serve as an example. In addition to this the fans are built on the alluvial floor of the creek which has been made since glacial times.

PHYSIOGRAPHY.

Springs.

The springs of the area are to be found mostly in the limestone regions. They owe their origin to underground drainage. None are mineral springs so far as the writer knows. They furnish the water supply for the city of Bloomington and supply the water for domestic use throughout the region where they are found.

Abandoned Swamps.

About three-quarters of a mile north of the Lemon schoolhouse, on the top of the north bench of Ellet's hill, is a deposit of iron ore gravel. This limonite is scattered over a large area and is evidence of the existence of a large swamp which has now dwindled down to a pond. This swamp probably dates back to glacial times. It was most likely formed between the foot of the ice-sheet and the ridge that terminates Ellet's hill at the south.

Salt Licks.

Several salt licks are to be found in Indian Creek and Bean Blossom valleys. They seem to be evidence of saline shales beneath the valley floors.

Boulders not Glacial in Origin.

In a ravine just north of Ellet's hill, about a mile northwest of Lemon Post Office, are several large bowlders some of which will weigh several tons. These bowlders are not glacial in origin because they are neither scratched nor worn, but are large concretions weathered from the adjacent sandstones of the ravine. That this conclusion is correct is attested by the fact that a half-weatheredout concretion of large size is in situ projecting from the sandstone wall of the ravine near by. The concretions are largely composed of silica and are very hard.*

Lost Ridges.

Standing in line with a point between White River on the left and Bean Blossom Creek on the right in section 5, Bean Blossom Township, is a subcircular knob called Indian or Pasture Mound. This mound being

*In the vicinity of these bowlders were several granite bowlders of glacial origin.

in line with the mound to the north and being composed of the same kind of material suggests that the two were once continuous and are yet continuous beneath the valley floor.

South of Bean Blossom Creek, opposite the railroad cut in section 9 of the same township, there is another ridge standing in line with the projecting "mainland" east of Jack's Defeat Creek. It is almost a third of a mile in length, about 400 yards wide and some 80 feet above the valley floor. It seems to have been a ridge between Jack's Defeat and Bean Blossom creeks before the aggrading of the valley floor caused the former creek to change its channel to the east through a former wind gap in the ridge. This left the ridge isolated.

North of the Bean Blossom, in section 24 of this same township, there is another conspicuous ridge known as "Lost Ridge." It is in line with the "main land" to the north, from which it is separated by only about a hundred yards of flat floor, through which a small stream runs from the Bean Blossom Valley to join Indian Creek. In this case, as in the previous one, the trend of the slope and the trend of the adjacent valley slope, together with the fact that the composition of the rocks is identical, suggest attachment beneath the present valley floor. There are several other similar islands in the Bean Blossom Valley.

These bits of relief are "islands" surrounded by alluvial material. They strongly attest that the Bean Blossom Valley has been aggraded very considerably.

Half Submerged Points and Peninsulas.

Several tied-on, peninsula-like ridges, known as knobs and points, project from the valley walls into the valley of Bean Blossom Creek, with the connecting neck almost submerged beneath the alluvium of the valley. They also attest to the aggrading of the valley.

Abandoned Valleys.

In the glacial region on the south side of Bean Blossom Creek several of the short valleys that were filled with glacial debris still remain filled. The glacial filling of the other valleys have been removed wholly or in part. Those which remain filled have had no springs at their heads since glacial times. Since much of the drainage of that part of the county is underground drainage the little valleys have remained filled.

Young Valleys.

The steep-graded, V-shaped valleys of the south side of the Bean Blossom Valley have already been described in this article and shown to be postglacial. In writing of these valleys Prof. Marsters says:*

"Traversing the steepest slopes of Bean Blossom are to be found numerous V-shaped valleys, with remarkably steep channels, ending their lower course at the point of intersection of the valley floor with the adjacent slope. In all cases small alluvial fans are built on the valley floor with their apex projecting but a few feet or yards at most beyond the mouths of the young valleys. In none of the observed cases was it found that the level of the valley floor would extend into the mouth of the young valley. It is therefore believed that the greater part of the cutting of these young valleys may date subsequent to the preglacial filling. The fact that alluvial fans and not deltas with steep outer edges and flat tops occur at their mouths, suggest that they have been constructed since the laking of the valley, and hence are regarded postglacial."

Reversed Drainage Due to Aggrading.

In section 24, Bean Blossom Township, the little stream which flows through the little gap between the "mainland" and Lost Ridge normally should flow direct to Bean Blossom Creek instead of into Indian Creek. Its head waters are in Bean Blossom Valley proper, not in Indian Creek Valley. The reversal of drainage is due to the aggrading of Bean Blossom Creek, so that the fall is greater through the gap.

Change of Channel Due to Aggrading.

Jack's Defeat Creek, running northeast from Stinesville, from all appearances normally ran just east of the Monon Railroad track between the "mainland" and the lost ridge, previously described, to join the master stream. With the aggrading of Bean Blossom Creek this little creek likewise aggraded itself until, having dammed its lower course with debris, it turned east and joined Bean Blossom farther up stream.

Abandoned Channels.

There are two abandoned channels of considerable size in the region. The one, that of Jack's Defeat Creek, between the "main land" and the

*Loc. cit. p. 236.

lost ridge just east of the railroad, has already been mentioned. The other channel extends from the top of the divide just north of the Abel schoolhouse west to the limestone ridge that is half submerged beneath the sand just east of the railroad track in section 5, Bean Blossom Township. It is about a mile in width and extends from the Bean Blossom Valley north to the White River Valley. The bed of this channel, which is now filled with glacial sand, is at least twenty-five feet below the present surface, as is attested by the sections taken in the wells of the region. The origin of this channel is still undetermined. The data at hand seem to suggest that after the retreat of the ice-sheet from the immediate vicinity, an ice-gorge dammed White River and compelled it to cut a new channel. After the breaking of the ice dam the river, as the new channel was not as deep as the old, abandoned the new and resumed the old channel. As it was being abandoned the new channel became a slack water region in which was deposited the sand which now fills it.

Wind Gaps.

There are many wind gaps in the area. They are the result of the degrading action of small streams on opposite sides of a divide. The streams have etched back their respective channels until they have cut through the divide, thus forming a wind gap. Conspicuous among these are Canada and Hubbard's gaps. These two gaps are both on the divide between White River and Bean Blossom Creek. They were both in existence in glacial times as they have glacial material deposited in them. In each rested the foot of the ice-sheet, and through each was carried south into the Bean Blossom Valley large quantities of glacial debris as has been shown in the discussion of the deltas of Indian and Honey creeks; the latter creek heading in Hubbard's Gap and the former in Canada Gap. These gaps are in interest now as they furnish prospective routes for steam and electric railways.

Bean Blossom Creek.

Bean Blossom Creek enters Monroe County from the east a little south of the northeast corner of the county and flows a little south of west to the northwest corner of Bloomington Township.* Here it changes its direction to a northwest course. It continues in this direction until it

*The change in the course of this creek is due to its sheering off to the northwest on coming in contact with the harder Harrodsburg and Salem limestones. Its lower course follows the trend of these out-crops.

enters White River a mile below Gosport. Throughout the county it has a wide, flat-floored picturesque inner valley, averaging a mile in width, the sides of which range from 100 to 200 feet in height. In this valley the present diminutive creek persists in keeping to the southwest side. The slopes of the valley usually range somewhere between 25° and 40°; the steeper slopes being usually on the south side, the south slopes of Ellet's hill and Mt. Tabor north of the creek being the only examples to the contrary. Rimming the valley slopes are a number of benches of variable widths, as has been previously noted, while projecting above the alluvium of the valley are hummocks and ridges, "islands" whose content is precisely the same as the country rock on either side of the valley. Beside these, tongues, promontories and tied-on ridges project into the valley.

This stream has had a varied history as has been already roughly outlined. It will be discussed under three heads, Preglacial, Glacial, and Postglacial history.

Preglacial History of Bean Blossom Creek.

At the close of the Mississippian period, or later in preglacial time, Bean Blossom Creek incised its channel to a depth much below its present level. That the incision was made in preglacial time is indicated by the following facts: (1) The old valley is now half filled with debris some of which is glacial in origin. (2) Its tributaries to the north as well as the wind gaps due to preglacial drainage likewise have glacial debris in them. (3) The glacier which crossed the northwestern part of Monroe County passed over and filled the creek, as is evidenced by the sand and glacial drift left in its valley. That the channel was deeper in preglacial time than now is demonstrated by the following evidence: The creek now meanders on a flat floor a mile in width. The floor, which is composed of alluvium for the most part, is still being aggraded. (2) Wells dug in the valley floor north of the channel, show that the loose material has great thickness. Mr. James Hughes' well, at his home on the road one mile east of Mt. Tabor nearly in the center of the southeast quarter of section 10, is 65 feet deep, yet it does not penetrate the entire thickness of the valley filling at that place. (3) Many of the meander-cut slopes have been largely buried beneath the valley filling. (4) Many of the tributary valleys, such as Jack's Defeat Creek, are aggraded for some distance up stream.

After incising the valley and widening it by meander cutting, Bean Blossom Creek began to aggrade its channel and at the close of the preglacial time had filled it nearly to the level it is today. The evidence in favor of such a conclusion is as follows: (1) At all points where the creek was protected from the invasion of glacial debris by promontories, such as Mt. Tabor and Ellet's hill, it still flows on the north side of its valley. At all other places it was driven to the south side by glacial debris. (2) The greater part of the clay and silt occupying the valley floor is of precisely the same kind as that covering the unglaciated highlands and valley slopes. It is evident that this filling simply represents the wash and soil-creep from the slopes and uplands on either side of the valley. (3) At the mouth of the creek where the glacier crossed the country only a patchy film of sand associated with bowlders composed partly of crystalline rocks cover the underlying clays, silts, etc.

This conclusion agrees with the following statement of Prof. Marsters concerning the preglacial filling of the valley:

"Inasmuch as the greater part of the clay and silt occupying the valley floor is precisely the same in kind as that covering the unglaciated uplands and valley slopes, it is evident that this filling simply represents the wash and soil-creep from the slopes and uplands on either side. Moreover, the rate of filling was so far in excess of the ability of the stream to carry off its load that the preglacial valley became clogged with the waste to such a degree that the stream now occupying the valley floor is for much of its course quite unable to spread its meanders over the entire width; only at the narrowest sections does Bean Blossom succeed in occupying the entire valley from slope to slope.

"Inasmuch as the filling of Bean Blossom at its mouth and for some little distance up stream is covered over by a patchy film of glacial sand associated with bowlders, composed partly of crystalline rocks, the underlying clays, silts, etc., antedate the glacial coating. Moreover, the occurrence of benches (to be associated with the glacial history) resting upon the valley filling also point to the same conclusion, that the present filling of the valley, less the benches and the glacial sands, etc., near the mouth of the valley, is preglacial."

The valley fillings, less the glacial sand, are, therefore, mostly preglacial.

Glacial History of Bean Blossom Creek.

As has been previously stated Bean Blossom Creek was laked by the ice-sheet which crossed its lower course. At the time of its laking there were deposited in its valley the deltas together with the loose materials that now cover the benches on either side.*

Post-Glacial History of Bean Blossom Creek.

Since glacial time Bean Blossom has been a diminutive, meandering creek in a broad, flat-floored valley, and throughout all postglacial time it has persisted in keeping to the south or west side of its valley. Evidently it does not fit its present valley. This fact suggests that the creek has not been able, on account of its diminutive size and the lack of time, to do much constructive work since the ice retreated. It is now at grade for ten miles above its mouth and must be actually aggrading its channel.

We quote Prof. Marsters for a more detailed description of this topic.**

"Since the close of the laking stage Bean Blossom River has developed a meandering course on its broad floor. Only in the narrowest sections of the valley has it succeeded in spreading its meander belt across the entire floor. For the most part it keeps to the west or south side of the valley, and yet still assumes a meandering habit for considerable stretches. In other words, the stream does not fit the present dimensions of the broad valley, which, accordingly, must have been brought about by other conditions than that resulting from lateral cutting, by a mature stream. Cross sections of the valley at its broadest places reveal a slight curvature of surface in the center and occasional abandoned meandering channels. This slight variation from a plain surface suggests flood plain construction. Whether this constructive work antedates the glacial episode of Bean Blossom is not certain, but it would seem from the data at hand, that the present postglacial Bean Blossom has not had time or the ability to do much constructive work since pleistocene time."

Two more things of interest in connection with Bean Blossom Creek remain to be explained. They are: (1) The reason for the channel of the creek keeping to its south bank, and (2) the reason why the slopes on the south side of the valley are steeper than those on the north.

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*See Marsters, loc. cit. for further discussion of this subject.

**Loc. cit. p. 236.

The explanation of the former seems to be that the branches from the north carried in much more material than those from the south. The tributaries from the north are more numerous and larger than those from the south and carried into the valley great quantities of glacial material from the foot of the ice-sheet or material from the slopes near its foot. This caused a greater accumulation of sediment on the north side of the valley, and the deltas thus formed drove the stream to the south side of the valley. The deltas of Buck and Wolf creeks, for example, extend nearly across the valley to the south side. Where Mt. Tabor, or Ellet's Hill, protected the valley from glacial or upland sediments from the north, the channel finds its way to the north bluff. To sum up, it seems from the foregoing statements that the creek keeps to its south bluff because of accumulated material from its tributaries in the north side of the valley.

The answer to the other question, Why are the valley slopes steeper south of Bean Blossom than north of it? seems to be as follows: It was observed that the variation in the slope had a direct relation to the minuteness of dissection, or the spacing of the streams crossing it, and that the closer the streams are to each other, the more subdued the slope. As a greater number of streams cross the valley slope on the north side of the valley we find the more subdued slopes on that side. In addition to this the stream occupying the south side of the valley has confined its side-cutting to that side which has tended to keep these bluffs steeper.

Mineral Resources.

The principal mineral resources are rock, sands and clays. The rocks having been mentioned as to use and value, the sands and clays remain to be discussed.

Sand.

The sand of the area is in the vicinity of Mt. Tabor, and between that point and Gosport. This sand is very fine and flour-like and, consequently, it is not a plastering sand. However, it is a good quality of moulding sand and may be used for paving purposes. For these purposes it has been satisfactorily tried, several car loads being used. There is, besides detached patches, a continuous sand area covering several square miles to a depth of 20 to 40 feet.

The residual clay derived from the breaking down of the Harrodsburg limestone is very stiff and of a deep red color. The clay resulting from the decomposition of the Knobstone shales is usually blue except on weathered surfaces, where it is light yellow. All the other clays of the region, those of the deltas being good examples, are yellow.

The blue clay is derived from the blue stone and shale of the Knobstone. Only three patches of this clay were noticed, one north of Bean Blossom Creek near the Brown County line, one just across Honey Creek on the road east of Fleener, the other in the delta (bench) south of Muddy Flat Creek, about a half mile south of Dolan. There are probably several other patches of this clay in the area, but as my investigations did not have reference to clays, no particular search was made for them. The clay of the first two patches mentioned is residual, while that of the last is probably stream wash and about 25 feet deep. On being burned in a kiln it burns white. The foreman of the tile mill at Dolan states that it is a good potter's clay. In burning tile the blue clay is mixed with equal parts of the yellow clay. This mixture produces a tile of fair quality.

Both the delta and bench formations in the Bean Blossom Valley are yellow above and sometimes down to a depth of 20 feet. This clay is the same in appearance as the yellow clay at Dolan that is made into tile. It is the opinion of the writer that a large tile and brick industry could be built up in this valley.

Indiana University, December 31, 1903.

GEOLOGY OF THE FORT APACHE REGION, ARIZONA.

BY ALBERT B. REAGAN.

(By title.)

What is the Age of the Aubrey Limestone of the Rocky Mountains?

By Albert B. Reagan.

The Carboniferous rocks of the Rocky Mountains are divided lithologically and palaeontologically into two distinct groups: The Red Wall and the Aubrey groups. The Red Wall is divided on palaeontological grounds into the Upper and Lower Red Wall, and the Aubrey on stratigraphical and lithological grounds into the Upper and Lower Aubrey. The Upper Aubrey is usually called the Aubrey Sandstone, the Lower Aubrey the Aubrey Limestone. In this paper it is the writer's purpose to establish the age of the last named group.

This group of rocks rests conformably upon the Upper Red Wall and shows conclusively by its position that it is Palaeozoic. Then as the Upper Red Wall is Coal Measures in age (see paper on "The Fossils of the Upper Red Wall Compared with those of the Kansas Coal Measures"), the Aubrey Limestone must be either Upper Carboniferous or Permian. Its position immediately above the Red Wall suggests the former; that is, that it is Upper Carboniferous. This conclusion is attested by the fossils identified from the group. They are: *Seminula argentia*, *Productus punctatus*, *Productus semi-reticulatus*, *Productus costatus* (?), a *Productus closely allied to if not*, *P. portlockianus*, *Spirifer cameratus*, *Bellerophon*, *Spirifer lineatus*, *Euomphalus pernodosus*, *Aviculopecten occidentalis* *Aviculopecten*, a *Hemipronites* (Gilbert), *Mekella striata-costata*, etc.

These fossils were all obtained in the first 100 feet of the Aubrey Limestone. They are all Upper Carboniferous, not Permeo-Carboniferous, in age, and therefore establish the age of the rocks in which they are found to be Upper Carboniferous beyond a doubt.

Note.— A few shells (*Pleurophorus*, *Schizodus*, and *Bakevella*) found by Mr. Gilbert (U. S. Geographical Surveys west of the 100th meridian, vol. 3, page 177) in the topmost layer of the Aubrey Limestone suggests the Permeo-Carboniferous of the Mississippi Valley. This would seem to imply that the Aubrey Sandstone which is conformably superimposed on the Aubrey Limestone is Permeo-Carboniferous in age.

Some Fossils from the Lower Aubrey and Upper Red Wall Limestones in the Vicinity of Fort Apache, Arizona.

By Albert B. Reagan.

The Fort Apache region, Arizona, is the home of the White Mountain Apache Indians. The region, as described in the November number of the American Geologist for 1903, is included between the parallels 33° 15′ and 34° 15′, and the meridians 109° 30′ and 111°. In this region, practically all the geological ages are represented from the Archæan to recent. The Carboniferous Age, to which the fossils belong, is represented by the Aubrey and Red Wall groups of rocks. Each of these groups is separated geologically and stratigraphically into two divisions; the Aubrey into the Upper and Lower Aubrey, and the Red Wall into the Upper and Lower Red Wall. The fossils were collected from the Upper Red Wall and Lower Aubrey divisions. Those from each division were collected separately, and their exact position will be given in the description.

FUSULINA FISCHER (1837).

FUSULINA SECALICA.

Plate, Figs. 1 a, b.

White's description (in part): Shell varying from terete to subglobose, assuming all intermediate fusiform shapes, generally somewhat obtusely pointed, usually having the appearance of being slightly twisted at the ends; septal furrows moderately distinct, extending in more or less direct lines longitudinally, but are a little deflected just at the ends; centrifugal apertures about twice as high as the thickness of the cell-wall covering them, more than twice as broad as high, and of nearly uniform size throughout the whole coil.

The locular or external aperture is seldom clearly shown upon the fossils. It was apparently linear the full length of the shell until closed by a new longitudinal septum at each side, leaving only a new centrifugal aperture at the middle, in line with the others. Volutions from five to eight; septa from twenty to thirty in outer volution; septa nearly straight at their outer or external edges, but laterally undulating at their inner edges, where they join the outer surface of the next volution within,

as may be seen in specimens that have had a part of their outer volution removed by weathering.

Dimensions very variable.

Position and Locality.—Strata of the Upper Red Wall, north bank of White River, twelve miles southwest of Fort Apache, Arizona. A few specimens of this species were also seen at several other places in the Fort Apache region as follows: At the crossing of the government trail on Carrixo Creek, on west bank of Cibucu Creek, one mile north of U. S. Indian farmer's residence, and on the east edge of the bluff one half mile northwest of agent's residence at White River, Arizona.

CAMPHOPHYLLUM.

[Milne-Edwards and Haime, Brit. Foss. Corals, Pl. LXVIII (1850).]

CAMPHOPHYLLUM TORQUUM.

Plate, Figs. 2 a, b, c.

Simple, usually large, conical to subcylindrical corallum, which in the case of specimens under three inches in length is usually bent or geniculated, but in larger specimens is nearly straight. Epitheca thin, with small encircling wrinkles and strong undulations of growth. Calice not seen. Septa very numerous, strictly radial in arrangement, extending about two-thirds the distance from the exterior toward the center, stout and usually straight within the outer vesicular zone, but becoming attenuated and somewhat curved or a little flexuous in crossing the vesicular area, where they alternate with an equal number of very short, thin ones. Visceral chamber filled with numerous imperfectly developed tabulæ, which pass nearly horizontally across the cavity with a more or less upward arching. Vesicular dissepiments highly developed in the periferal portion, forming numerous obliquely ascending small vesicles. Entire length unknown.

Range and Distribution.—Red Wall Group, Fort Apache, White River, Salt River, Carrixo Creek at the crossing of the government trail, and on Cibicu Creek, one mile north of the U. S. Indian farmer's residence, Arizona.

ACERVULARIA Schweigg.

ACERVULARIA DAVIDSONI Milne—Edwards and Haime.

[Pal. Foss. des Terr. Pal. P. 418, Pl. 9, Figs. 4-4 b (18—).]*

Coral composite, astræiform and massive, composed of unequally sized, usually five or six-sided corallites, having both an outer and an interior, slightly undulated or zigzag wall. The outer wall is thin; the inner wall is rarely well defined; the surface sinks, at first gradually and then abruptly, to form the cup, the diameter of which is about one-fifth of an inch. The bottom of the true calice is flat to slightly elevated. The septæ are radially arranged, and are stout and finely denticulate, there being about seven denticulations in the space of one line. They are usually about forty-two in number, and for the most part, extend into the true calice. The tabulæ are abundant in the central area; the dissepiments abundant in the periferal zone. The diameter of the larger corallites is about one-half inch.

This species is most nearly allied to *A. Profunda* Hall, from which it is distinguished by the larger size of the corallites, the greater constancy in the size of the calices, the less number and less conspicuous denticulation of the septa, and in the zigzag undulations of the outer walls.

Range and Distribution.—Devonion formation, on the government trail, four miles east of Canyon Creek, Arizona; on the John Dazen trail, three-fourths mile southeast of the cliff houses near Oak Creek, and along the rim of the Tonto basin, Arizona; at the falls of the Ohio and at Sandusky, Ohio, etc.

CERIOCRINUS?

Plate, Fig. 3.

The specimens referred to this genus are a few detached plates and are insufficient to fully identify even the genus.

Position and Locality.—Upper Red Wall, north bank of White River Canyon, twelve miles southwest of Fort Apache, Gila County, Arizona.

ARCHÆOCIDARIS McCoy.

ARCHÆOCIDARIS.

Plate, Fig. 7.

The specimens here called *Archæocidaris* are some fragments. They are too imperfect for identification of the species; but, though much worn, are sufficient to identify the genus.

* For a figure of the fossil here described the reader is referred to plate XXX of the November number of the American Geologist for 1903.

Position and Locality.—Upper Red Wall, north side of White River Canyon, twelve miles southwest of Fort Apache, Arizona.

FENESTELLA?

Plate, Fig. 4.

Bryozoa; reverse side, branches ridged, long and generally straight; dissepiments from one-fourth to one-half the size of the branches; surface covered with a porous calcareous covering.

Position and Locality.—Upper Red Wall, near Fort Apache, Arizona.

PUGNAX HALL (1893).

PUGNAX UTA.

Plate, Figs. 8 a, b.

Meek's description: Shell small, more or less variable in form, often subtrigonial, generally wider than long, more or less gibbous; front truncated, or sometimes sinuous in outline; anterior lateral margins rounded in outline; posterior lateral margins convex or nearly straight and converging toward the beak at an angle of from 90° to 120°. Dorsal valve more convex than the other, greatest convexity near the middle or between it and the front, which has a broad, rather deep, marginal sinus for the reception of the corresponding projection of the front of the other valve; mesial fold somewhat flattened, but slightly prominent, and rarely traceable back of the middle of the valve; generally composed of three but sometimes four—rarely more—plications; side rounding down rapidly on each side of the mesial fold, and each occupied by about three or four plications; beak curving strongly beneath that of the other valve; interior with a faint linear mesial ridge, on each side of which is a raised curved line enclosing an ovate space, occupied by the abductor muscular impressions. Ventral valve distinctly less convex than the other, with a broad, shallow, short sinus, occupied by about two or three plications; anterior lateral margins on each side of sinus, with from two to four plications; beak moderately prominent, and more or less arched, rather pointed; foramen small."

Position and Locality.—Upper Red Wall, north bank of White River, twelve miles southwest of Fort Apache, Arizona.

AMBROCÆLIA Hall (1860).

AMBROCÆLIA PLANOCONVEXA Shumard.

Plate, Figs. 9 a, b, c.

White's description*: "Shell very small; breadth varying from a little more to a little less than the length; hinge-line of considerable length, but always shorter than the full width of the shell in front of it; lateral and front borders regularly and continuously rounded.

The dorsal valve would be almost circular but for its truncation by the hinge-line; nearly flat, but slightly convex at the umbo, and sometimes slightly concave at the front; beak minute, not prominent; area very narrow.

Ventral valve capacious, especially its posterior portion, which extends much behind the hinge-line, and ends in a prominent strongly incurving pointed beak; area very narrow, high, concave, mesial sinus absent, but in its place there is usually a slight flattening at the front and sometimes an indistinctly impressed line is to be seen extending from beak to front.

Surface apparently smooth, but under a lens it is seen to be finely granular, the apparent granules being the bases of minute striæ; a few concentric lines of growth are observable upon both valves."

Position and Locality.—Strata of the Upper Red Wall, north bank of White River Canyon, twelve miles southwest of Fort Apache, Arizona.

RETICULARIA McCoy (1844).

RETICULARIA PERPLEXA.

Plate, Figs. 10 a, b.

Shell ordinary size, nearly circular in outline; breadth a little more and convexity a little less than the length; hinge-line shorter than the full width of the shell in front of it; lateral and front borders regularly and continuously rounded; cardinal area distinct, arched, and moderately high.

Ventral valve convex, extending much behind the hinge-line in a prominent, strongly incurved beak; area small; mesial sinus absent, but in its place there is a slight flattening at the front and three indistinctly impressed lines are to be seen extending from front to beak. This flattening gives to the shell a slight sinuosity.

*White, U. S. Geog. Surv. W. of the 100th meridian, Vol. IV, P. 135, Pl. 8, Figs. 10 a, b, c

Dorsal valve circular in outline except where truncated by the hinge-line; regularly convex; beak less prominent than that of the other valve, extending beyond the hinge-line; area very narrow.

Surface marked by very numerous almost indistinct radiating costæ and by somewhat strong concentric markings.

Position and Locality.—Upper Red Wall Group, north bank of White River Canyon, twelve miles southwest of Fort Apache, Arizona.

DIELUSMA King (1859).

DIELUSMA BOUVIDINES (Morton).

Plate, Fig. 11.

White's description (in part)*: Shell ovate or elongate-ovate in outline; sides behind the middle laterally compressed. Ventral valve strongly arcuate from front to beak, the curvature being greatest behind the middle, rather more capacious than the other valve; beak prominent, incurved; foramen moderately, not squarely, truncating the beak, but opening obliquely backward, mesial sinus broad, and more or less distinct at the anterior part of the valve, but becoming obsolete at or behind the middle. Dorsal valve generally almost straight along the median line from front margin to a little behind the middle, from which part it gently curves to the beak; gently and somewhat uniformly convex from side to side, without a mesial fold.

Surface nearly smooth; shell structure finely punctate.

Position and Locality.—Upper Red Wall Group, Fort Apache, Arizona.

SEMINULA McCoy (1844).

SEMINULA ARGENTIA Shepard.

Plate, Figs. 12 a, b, c, e.

Shell varying considerable in outline, generally subovate; seldom as wide as long, usually moderately gibbous, but sometimes old shells are much inflated. Ventral valve generally a little more capacious than the dorsal; beak rather prominent, incurved; mesial sinus usually not very deep, and becoming obsolete about the middle.

*U. S. Geog. Surv. W. of the 100th meridian, Vol. IV, P. 144, Pl. XI, Figs. 10 a, b, c.

Dorsal valve somewhat uniformly convex, but most prominently so near the umbo; beak small, slightly prominent, mesial fold entirely wanting as a rule. Surface marked by faint traces of radiating striæ and by occasional imbricating lines of growth.

Range and Distribution.—Upper Red Wall group and Lower Aubrey; Carrixo Creek, at the confluence of White and Black rivers, and on either side of White River in Maricopa County, and at Fort Apache and at Jemez, New Mexico, White River, Arizona, etc. Common throughout the upper carboniferous of America and in England and India in the subcarboniferous also. Its range also extends into the Permian.

MYALINA de Konnick, 1844.

MYALINA?

Plate, Fig. 13.

The specimen here figured in outline is too badly crushed to warrant a description, but is obviously a member of the genus Myalina.

Position and Locality.—Upper strata of the Upper Red Wall, south side of White River Canyon, one mile west of Fort Apache, Arizona.

EUOMPHALUS Sowbery (1815).

EUOMPHALUS PERNODOSUS Meek and Worthen.

Plate, Figs. 14 a, b, c, e

White's description* (in part): "Shell rather above medium size when full grown, nearly discoidal, the spire being only very slightly elevated, and the inner portion of it being quite flat, or evenly depressed. Test thick, volutions five or six, the upper side flattened and sloping gently inward to the distinct suture, outer side flattened, convex, under side rounding; the angles formed by the upper and outer sides constitute a distinct carina which is rugose or corrugated upon the outer volution; upon the under side of the volutions there is a row of moderately large, rounded nodes, separated by spaces of about their own width, those of the last half of the outer volution being obsolete;" umbilicus not seen.

*U. S. Geog. Surv. W. of the 100th meridian, Vol. IV, P. 158, Pl. 12, Figs. 2 a, b, c.

PLATE EXPLANATION.

Fig. 1. Fusulina secalica.....

1 a. A specimen showing the septal furrows and the centrifugal aperture.

1 b. Some weathered specimens.

Fig. 2. Camphophylum torquum.....

2 a. Longitudinal view of a portion of a coral.

2 b. Cross section.

2 c. A longitudinal section showing tabulæ.

Fig. 3. Some crinoid plates.....

Fig. 4. Fenestella ? .....

Fig. 5. ? Rhombopera ? .....

Fig. 6. Hemeitrypa ? .....

Fig. 7. Archæocidaris spines..... .....

Fig. 8. Pugnax uta .....

8 a. Ventral valve.

8 b. Dorsal valve.

Fig. 9. Ambocælia planoconvexa .....

9 a. Dorsal view.

9 b. Ventral view.

9 c. Side view.

Fig. 10. Reticularia perplexa .....

10 a. Ventral valve.

10 b. Dorsal valve.

Fig. 11. Dielasma bovidines, dorsal view..... .....

Fig. 12. Seminula argentia ....

12 a. Ventral valve showing sinus.

12 b, f and g. Dorsal views.

12 c. Dorsal view of a young specimen.

12 e. Side view.

12 m. An old specimen.

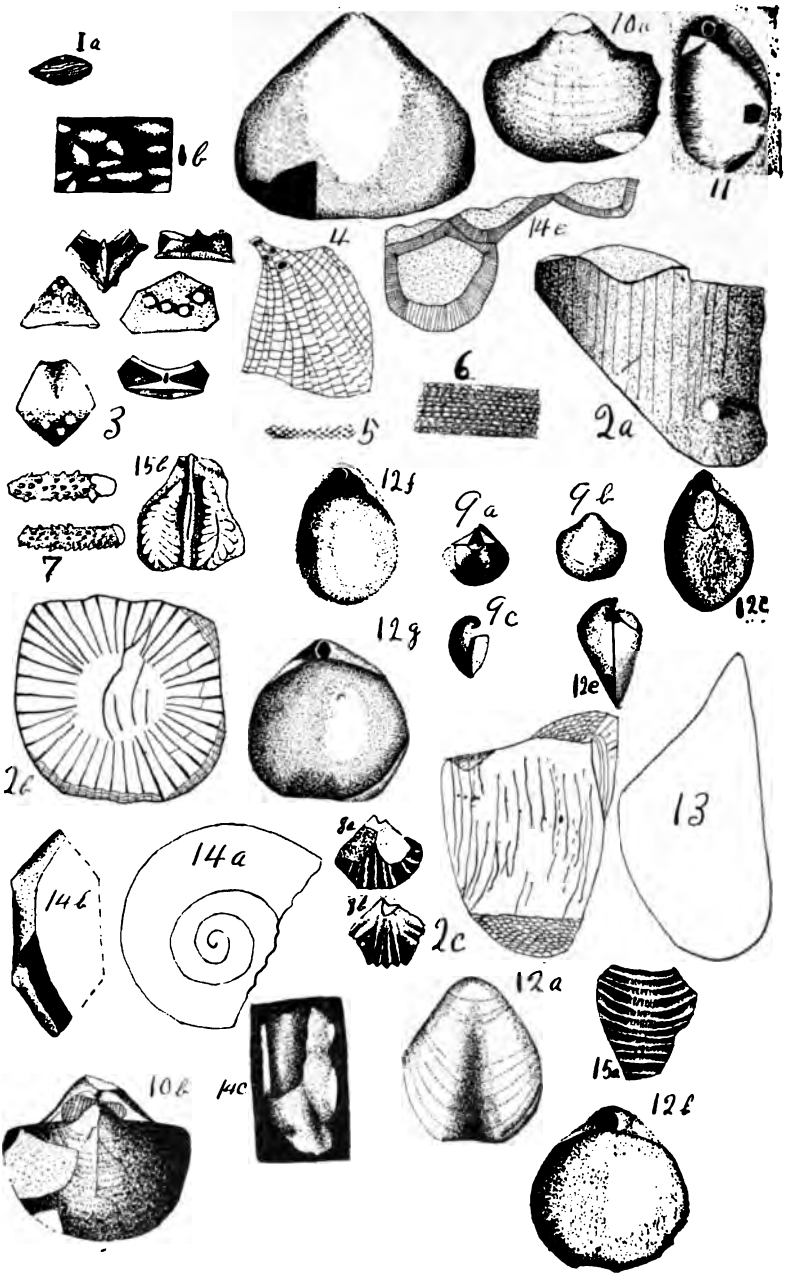
Fig. 13. Myalina ? Outline only.....

Fig. 14 a, b, c, e. Fragments of an Euomphalus pernodosus.....

Fig. 15. Productus punctatus .....

15 a. A portion of the dorsal valve.

15 b. Inside of dorsal valve, showing muscular impressions.


1a
1b
10a
11
4
14e
6
5
2a
3
15c
12f
9a
9b
7
12g
9c
12c
12e
2c
13
14a
14b
3a
3b
2c
12a
15a
10b
4c
12b

Position and Locality.—In limestone strata at top of the lower Aubrey group, Aubrey Cliff, one mile northeast of White River, and at the crossing of the government trail on Carrizo Creek, Arizona.

CALAMARIÆ.

CALAMITES.

CALAMITES CANNÆFORMIS.

Long, slender, tapering reed-like stem, jointed and having a large pith. Its exterior surface is finely striated, but the striæ are not continuous, but are interrupted at the joints by a "break." The striæ on each side of said "joint break" correspond to each other. Each stria has a small pinhead-like projection on it near its upper extremity. The bark which was left in the cast is about 1-132 of an inch in thickness. It seemed to be fibrous. The striæ impressions and the grooves between the striæ which were filled with the bark tissue show very distinctly, the latter being ridges on the inside of the bark, the former depressions. The leaves were strap-like (?) the stem is flattened and in its longer diameter, three feet above the ground it exceeded five inches. At its lower end the joints grow rapidly smaller and shorter, so that this end is conical, but so curved as to represent a dog's tearing tooth. From these lower tapering joints came out the small roots which nourished this peculiar tree and which were still found imbedded in the clayey stratum by the writer. The top of the stem was not found but it most likely was cone-like.

Habitat.—West of Cibicu Creek and one mile north of the Phœnix-Fort Apache trail, Arizona. The specimen above described was found imbedded in a shaley white sandstone, underlaid with a thin stratum of clay, into which the lower part of the above-mentioned tree extended. The location is on the east side of the mesa to the west of the aforementioned Cibicu Creek, and about 42 feet below its summit.*

*The specimen here described was sent to the university at Albuquerque, N. M., and is now in the collection there.

The Sun or Gunelpiya Medicine Disk.

By Albert B. Reagan.

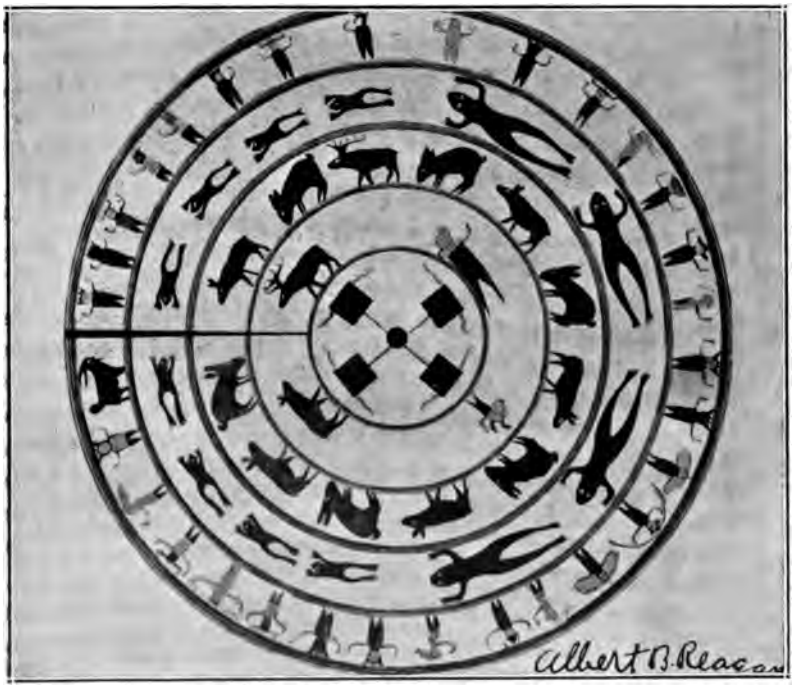
This disk is used as a last resort in the Apache medicine ceremonies. It is drawn on a leveled, sanded spot of ground some sixteen feet in diameter. The materials used in painting the figures are obtained as follows: The green is ground up leaves; the red, ground up sandstone; the yellow ground up limestone; the black, powdered charcoal. The rings separating the concentric spaces are rainbow circles. The central figure is the sun, and the squares associated with the sun are the medicine blocks. The first and second concentric spaces from the central area represent land; the space in which the frogs are swimming, water; and the outer concentric space, the abode of the gods.

This drawing is an Apache prayer in an elaborate form. In it they have all the gods of the universe represented, and on the mercy of these gods they throw the patient. As has been stated this is a last resort. The gods can either make the sick one well or take him to themselves, that is, to the Happy Hunting Ground.

When this drawing is completed, which is always at about four o'clock in the afternoon of the same day in which it was commenced, the patient is carried and placed on the central figure with face toward the evening sun. A medicine dancer wearing a ghost hat then enters the medicine circle, and, carrying a bowl partly filled with water in one hand, he takes a pinch of dust from each of the representative figures and puts it into the bowl. Having completed his dust-gathering, he proceeds to the sick one and daubs him all over with the muddied water. This being completed, he sends a hissing breath through his hands, thus expelling sick to the four quarters of the earth. He then leaves the medicine circle and gallops off into obscurity. When he has departed the chief medicine man, after sprinkling the patient with cattail flag pollen as he prays to the gods, takes up the bowl of muddied water left by the ghost dancer, and daubs the patient as the ghost dancer had daubed him before, while those present chant a medicine song to the gods. When he has completed his task, the oldest woman present takes the muddied bowl and continues the daubing process. Her act completes the ceremony. The sick one is then

carried from the scene and all who wish, gather dust from the representatives of the gods and put it into some containing receptacle, usually a tobacco sack. The dust gathering being completed, the medicine disk is at once obliterated. It must be made, used, and destroyed in a day.

On the night following the Gunelpiya medicine disk performances, the ghost dance is given for the benefit of the sick one. The next day the patient usually dies.



The Sun or Gunelpiya Medicine Disk.

The Fossils of the Red Wall Compared with Those of the Kansas Coal Measures.

By Albert B. Reagan.

For the purpose of definitely determining the age of the upper half of the Red Wall limestone of the Rocky Mountains the writer has prepared the following tabulated comparison of the fossils of that series of rocks with those of the Kansas Coal Measures. The Kansas fossils were taken from Dr. J. W. Beede's Carboniferous Invertebrates of Kansas (Univ. Geol. Surv. of Kansas, vol. VI, pp. 1-187, plates 1-22). Some of the Upper Red Wall fossils were identified by Prof. Meek (see Gilbert's Report, U. S. Geog. Surv. w. of the 100th meridian, vol. III, p. 178); some by Prof. White (see White's Report in vol. IV, U. S. Geog. Surv. w. of the 100th meridian); the others by the writer, under the direction of Dr. Beede of the University of Indiana. The fossils identified by Meek are marked (1), those by White (2).

RED WALL FOSSILS.	KANSAS FOSSILS.
Fusulina secalica.	Fusulina secalica.
	Anolopra anna.
Camphophyllum torquum.	Camphophyllum torquum.
	Limopteria alata.
	Trachypora austini.
Archæocidaris ?	Archæocidaris agassiz.
Archæocidaris tudifer.[1]	Archæocidaris tudifer.
Derbya ?	Derbya bennetti.
Derbya crassa.	Derbya crassa.
	Derbya cymbula.
	Derbya biloba.
Derbya Kuokuk.	Derbya Kuokuk.
Derbya affinis.	
	Chonetes granulifer.
Chonetes mesolobus.[1]	Chonetes mesolobus.
	Chonetes glaber.
	Chonetes vernemlianus.
	Productus pertenius.
	Productus symmetricus

Productus nebrascensis.	Productus nebrascensis.
Porductus costatus.[1] [2]	Productus costatus.
	Productus longispinus.
Productus semi-reticulatus.[2]	Productus semi-reticulatus.
Productus prattenianus.[1]	Productus cora.
Productus. ?	Productus sp.*
Productus, like P. portlockienus.	
Reticularia perplexa.	Reticularia perplexa.
Ambocœlia planoconvexa.	Ambocœlia planoconvexa.
Spirifera kentuckensis.	Spiriferina kentuckyensis.*
Hemipronites crinistria.	
Hemipronites crassus.[2]	
Spirifer cameratus.	Spirifer cameratus.
	Enteletes hemiplicata.
Pugnax uta.	Pugnax uta.
	Pugnax rockymontana
Meekella striatacostata.	Meekella striatacostata.
	Avinculopecten hertzeri.
	Avinculopecten providencensis.
	Avinculopecten sculptilis.
Avinculopecten interlineatus.[1] [2]	Avinculopecten interlineatus.
Avinculopecten occidentalis.	Avinculopecten occidentalis.
	Avinculopecten carboniferus.
	Avinculopecten McCoyi.
	Avinculopecten germanus.
Avinculopecten ?	Avinculopecten sp.*
Monoteria mariam.[1]	Limopteria mariam.
Myalina sp.	Myalina sp.
Myalina (?) swallovi.[1]	Myalina swallovi.
Nuculana (?).	Nuculana bellistriata.
Schizodus (?)[1] sp.	Schizodus wheeleri.
	Schizodus hari.
Rhombopora sp.	Rhombopora lepidodendroides.
Fenestella shumardi.[1]	Fenestella shumardi.
Fenestella sp.	Fenestella sp.
Polypora stragulata.[1]	Polypora sp.
Glauconome nereides.	Pinnatopora tenuilineata.
Synocladia biseralis.	

Fistulipora nodulifera.	Fistuipora nodulifera.
Modiola (?) ?	Modiola sulbelliptica.
Murchisonia sp.	Murchisonia sp.
Platysomus[2] sp.	
Phillipsia[2] sp.	Phillipsia sp.*
Nautilus occidentalis.	Nautilus planovolvis.
Euomphalus (like E. nodosus).[2]	Enômphalus sp.*
Euomphalus pernodosus.	Enomphalus pernodosus.*
Macrocheilus[2] sp.	
Pleurotomeria[2] sp.	Pleurotomeria tabulata.
	Pleurotomeria sp.
Bellerophon crassus.	Bellerophon crassus.
Dielasma bovidines.	Dielisma bovidines.
Seminula argentia.	Seminula argentia.

Of the 36 genera of the Upper Red Wall tabulated above, 32 are represented in the fossils of the Kansas Coal Measures, and of the 32 species identified 26 are identical. The tabulated comparison, therefore, determines the age of the Upper Red Wall of Arizona to be practically the same as that of the Kansas Coal Measures.

NOTE.—The species and genera marked (*) were taken from Bulletin 211 of the U. S. Geological Survey. Some of the other Kansas species (not marked) were taken from Dr. Beede's Report, Kansas University Science Bulletin, Vol. I, No. 7, September, 1902.

NOTICE.

Owing to the limitations of the appropriation and the length of the paper, it was found necessary to defer until 1904 the publication of the paper described below:

ECOLOGICAL NOTES ON THE BIRDS OCCURRING WITHIN A RADIUS OF FIVE MILES OF THE INDIANA UNIVERSITY CAMPUS.

BY WALDO LEE MCATEE.

With Photographic Illustrations by CLARENCE GUY LITTELL.

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Proceedings of the

Indiana Academy of Science

1904

PROCEEDINGS

OF THE

Indiana Academy of Science

1904.

EDITOR, - - DONALDSON BODINE.

ASSOCIATE EDITORS:

AMOS BUTLER, W. S. BLATCHLEY,
C. H. EIGENMANN, P. N. EVANS,
LYNN B. MCMULLEN, THOMAS GRAY,
JOHN S. WRIGHT.

INDIANAPOLIS, IND.
1905.

INDIANAPOLIS:
WM. B. BURFORD, PRINTER.
1905.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
February 15, 1905.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, February 15, 1905.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

D. E. SHERRICK,
Auditor of State.

FEBRUARY 15, 1905.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

UNION B. HUNT,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, February 15, 1905.

DANIEL E. STORMS,
Secretary of State.

Received the within report and delivered to the printer February 15, 1905.

THOS. J. CARTER,
Clerk Printing Bureau.

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AN ACT TO PROVIDE FOR THE PUBLICATION OF THE REPORTS AND PAPERS OF THE INDIANA ACADEMY OF SCIENCE.

[Approved March 11, 1895.]

Preamble.

WHEREAS, The Indiana Academy of Science, a chartered scientific association, has embodied in its constitution a provision that it will, upon the request of the Governor, or of the several departments of the State government, through the Governor, and through its council as an advisory body, assist in the direction and execution of any investigation within its province, without pecuniary gain to the Academy, provided only that the necessary expenses of such investigation are borne by the State; and,

WHEREAS, The reports of the meetings of said Academy, with the several papers read before it, have very great educational, industrial and economic value, and should be preserved in permanent form; and

WHEREAS, The Constitution of the State makes it the duty of the General Assembly to encourage by all suitable means intellectual, scientific and agricultural improvement; therefore,

Publication of the Reports of the Indiana Academy of Science.

SECTION 1. *Be it enacted by the General Assembly of the State of Indiana*, That hereafter the annual reports of the meetings of the Indiana Academy of Science, beginning with the report for the year 1894, including all papers of scientific or economic value, presented at such meetings, after they shall have been edited and prepared for publication as hereinafter provided, shall be published by and under the direction of the Commissioners of Public Printing and Binding.

Editing Reports.

SEC. 2. Said reports shall be edited and prepared for publication without expense to the State, by a corps of editors to be selected and appointed by the Indiana Academy of Science, who shall not, by reason of such services, have any claim against the State for compensation. The form, style of binding, paper, typography and manner and extent of illustration of such reports, shall be determined by the editors, subject to the approval of the Commissioners of Public Printing and Stationery. Not less than 1,500 nor more than 3,000 copies of each

Number of printed Reports.

of said reports shall be published, the size of the edition within said limits to be determined by the concurrent action of the editors and the Commissioners of Public Printing and Stationery: *Provided*, That not to exceed six hundred dollars ($600) shall be expended for such publication in any one year, and not to extend beyond 1896: *Provided*, That no sums shall be deemed to be appropriated for the year 1894.

Proviso.

SEC. 3. All except three hundred copies of each volume of said reports shall be placed in the custody of the State Librarian, who shall furnish one copy thereof to each public library in the State, one copy to each university, college or normal school in the State, one copy to each high school in the State having a library, which shall make application therefor, and one copy to such other institutions, societies or persons as may be designated by the Academy through its editors or its council. The remaining three hundred copies shall be turned over to the Academy to be disposed of as it may determine. In order to provide for the preservation of the same it shall be the duty of the Custodian of the State House to provide and place at the disposal of the Academy one of the unoccupied rooms of the State House, to be designated as the office of the Indiana Academy of Science, wherein said copies of said reports belonging to the Academy, together with the original manuscripts, drawings, etc., thereof can be safely kept, and he shall also equip the same with the necessary shelving and furniture.

Disposition of Reports.

SEC. 4. An emergency is hereby declared to exist for the immediate taking effect of this act, and it shall therefore take effect and be in force from and after its passage.

Emergency.

AN ACT FOR THE PROTECTION OF BIRDS, THEIR NESTS AND EGGS.

[Approved March 5, 1891.]

Birds.

SECTION 1. *Be it enacted by the General Assembly of the State of Indiana*, That it shall be unlawful for any person to kill any wild bird other than a game bird, or purchase, offer for sale any such wild bird after it has been killed, or to destroy the nests or the eggs of any wild bird.

Game Birds.

SEC. 2. For the purpose of this act the following shall be considered game birds: the Anatidæ, commonly called swans, geese, brant, and river and sea ducks; the Rallidæ, commonly known as rails, coots, mudhens, and gallinules; the Limicolæ, commonly known as shore birds, plovers, surf birds, snipe, woodcock and sandpipers, tattlers and curlews; the Gallinæ, commonly known as wild turkeys, grouse, prairie chickens, quail, and pheasants, all of which are not intended to be affected by this act.

Penalty.

SEC. 3. Any person violating the provisions of Section 1 of this act shall, upon conviction, be fined in a sum not less than ten nor more than fifty dollars, to which may be added imprisonment for not less than five days nor more than thirty days.

Permits.

SEC. 4. Sections 1 and 2 of this act shall not apply to any person holding a permit giving the right to take birds or their nests and eggs for scientific purposes, as provided in Section 5 of this act.

Permits to Science.

SEC. 5. Permits may be granted by the Executive Board of the Indiana Academy of Science to any properly accredited person, permitting the holder thereof to collect birds, their nests or eggs for strictly scientific purposes. In order to obtain such permit the applicant for the same must present to said Board written testimonials from two well-known scientific men certifying to the good character and fitness of said applicant to be entrusted with such privilege, and pay to said Board one dollar to defray the necessary expenses attending the granting of such permit, and must file with said Board a properly executed bond in the sum of two hundred dollars, signed by at least two responsible citizens of the State as sureties. The bond shall be forfeited to the State and the permit become void upon proof that the holder of

Bond.

Bond forfeited.

such permit has killed any bird or taken the nests or eggs of any bird for any other purpose than that named in this section, and shall further be subject for each offense to the penalties provided in this act.

Two years.

SEC. 6. The permits authorized by this act shall be in force for two years only from the date of their issue, and shall not be transferable.

Birds of prey.

SEC. 7. The English or European House Sparrow (Passer domesticus), crows, hawks, and other birds of prey are not included among the birds protected by this act.

Acts repealed.

SEC. 8. All acts or parts of acts heretofore passed in conflict with the provisions of this act are hereby repealed.

Emergency.

SEC. 9. An emergency is declared to exist for the immediate taking effect of this act, therefore the same shall be in force and effect from and after its passage.

OFFICERS—1904–1905.

PRESIDENT,
JOHN S. WRIGHT.

VICE-PRESIDENT,
ROBERT HESSLER.

SECRETARY,
LYNN B. McMULLEN.

ASSISTANT SECRETARY,
J. H. RANSOM.

PRESS SECRETARY,
G. A. ABBOTT.

TREASURER,
WILLIAM A. McBETH.

EXECUTIVE COMMITTEE.

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ROBERT HESSLER,	D. W. DENNIS,	J. L. CAMPBELL,*
LYNN B. McMULLEN,	C. H. EIGENMANN,	O. P. HAY,
J. H. RANSOM,	C. A. WALDO,	T. C. MENDENHALL,
G. A. ABBOTT,	THOMAS GRAY,	JOHN C. BRANNER,
WILLIAM A. McBETH,	STANLEY COULTER,	J. P. D. JOHN,
CARL L. MEES,	AMOS W. BUTLER,	JOHN M. COULTER,
WILLIS S. BLATCHLEY,	W. A. NOYES,	DAVID S. JORDAN.
HARVEY W. WILEY,		

CURATORS.

BOTANY	J. C. ARTHUR.
ICHTHYOLOGY	C. H. EIGENMANN.
HERPETOLOGY, MAMMALOGY, ORNITHOLOGY	AMOS W. BUTLER.
ENTOMOLOGY	W. S. BLATCHLEY.

*Deceased.

COMMITTEES, 1904-1905.

PROGRAM.

LYNN B. MCMULLEN, JOHN S. WRIGHT, A. L. FOLEY.

MEMBERSHIP.

J. H. RANSOM, R. L. LYONS, W. A. MCBETH.

NOMINATIONS.

J. C. ARTHUR, A. S. HATHAWAY, W. J. MOENKHAUS.

AUDITING.

THOMAS GRAY, A. J. BIGNEY.

STATE LIBRARY.

JOHN S. WRIGHT, A. J. BIGNEY, O. L. KELSO.

LEGISLATION FOR THE RESTRICTION OF WEEDS.

M. B. THOMAS, D. M. MOTTIER, C. C. DEAM.

PROPAGATION AND PROTECTION OF GAME AND FISH.

C. H. EIGENMANN, A. W. BUTLER, GLENN CULBERTSON.

EDITOR.

DONALDSON BODINE, Wabash College, Crawfordsville.

DIRECTORS OF BIOLOGICAL SURVEY.

C. H. EIGENMANN, STANLEY COULTER, CHARLES R. DRYER, M. B. THOMAS, J. C. ARTHUR.

RELATIONS OF THE ACADEMY TO THE STATE.

C. A. WALDO, WILLIAM WATSON WOOLLEN, R. W. MCBRIDE, G. W. BENTON.

GRANTING PERMITS FOR COLLECTING BIRDS AND FISHES.

A. W. BUTLER, D. W. DENNIS, W. J. MOENKHAUS.

DISTRIBUTION OF THE PROCEEDINGS.

THOMAS GRAY, L. J. RETTGER, JOHN S. WRIGHT, DONALDSON BODINE, H. L. BRUNER.

OFFICERS OF THE INDIANA ACADEMY OF SCIENCE.

	PRESIDENT.	SECRETARY.	ASST. SECRETARY.	PRESS SECRETARY.	TREASURER.
1885–6.....	David S. Jordan..	Amos W. Butler..	.....	.....	O. P. Jenkins.
1886–7.....	John M. Coulter..	Amos W. Butler..	.....	.....	O. P. Jenkins.
1887–8.....	J. P. D. John.....	Amos W. Butler..	.....	.....	O. P. Jenkins.
1888–9.....	John C. Branner..	Amos W. Butler..	.....	.....	O. P. Jenkins.
1889–90....	T. C. Mendenhall.	Amos W. Butler..	.....	.....	O. P. Jenkins.
1890–1.....	O. P. Hay	Amos W. Butler..	.....	.....	O. P. Jenkins.
1891–2.....	J. L. Campbell...	Amos W. Butler..	.....	.....	C. A. Waldo.
1892–3.....	J. C. Arthur.....	Amos W. Butler..	Stanley Coulter W. W. Norman	.....	C. A. Waldo.
1893–4.....	W. A. Noyes	C. A. Waldo.....	W. W. Norman.....	.....	W. P. Shannon.
1894–5.....	A. W. Butler.....	John S. Wright...	A. J. Bigney.....	.....	W. P. Shannon.
1895–6....	Stanley Coulter...	John S. Wright...	A. J. Bigney.....	.....	W. P. Shannon.
1896–7.....	Thomas Gray.....	John S. Wright...	A. J. Bigney	.....	W. P. Shannon.
1897–8.....	C. A. Waldo.....	John S. Wright..	A. J. Bigney.....	Geo. W. Benton ...	J. T. Scovell.
1898–9.....	C. H. Eigenmann.	John S. Wright...	E. A. Schultze	Geo. W. Benton ...	J. T. Scovell.
1899–1900..	D. W. Dennis.....	John S. Wright...	E. A. Schultze	Geo. W. Benton ...	J. T. Scovell.
1900–1901..	M. B. Thomas....	John S. Wright...	E. A. Schultze	Geo. W. Benton ...	J. T. Scovell.
1901–1902..	Harvey W. Wiley	John S. Wright...	Donaldson Bodine.....	Geo. W. Benton ...	J. T. Scovell.
1902–1903..	W. S. Blatchley..	John S. Wright...	Donaldson Bodine.....	G. A. Abbott	W. A. McBeth.
1903–1904..	C. L. Mees.....	John S. Wright...	J. H. Ransom.....	G. A. Abbott	W. A. McBeth.
1904–1905..	John S. Wright...	Lynn B. M'Mullen	J. H. Ransom.....	G. A. Abbott	W. A. McBeth.

In Memoriam

JOHN LYLE CAMPBELL

Born, Salem, Indiana, October 13, 1827.

Died, Crawfordsville, Indiana, September 7, 1904.

President Indiana Academy Science, 1891–1892.

CONSTITUTION.

ARTICLE I.

SECTION 1. This association shall be called the Indiana Academy of Science.

SEC. 2. The objects of this Academy shall be scientific research and the diffusion of knowledge concerning the various departments of science; to promote intercourse between men engaged in scientific work, especially in Indiana; to assist by investigation and discussion in developing and making known the material, educational and other resources and riches of the State; to arrange and prepare for publication such reports of investigation and discussions as may further the aims and objects of the Academy as set forth in these articles.

Whereas, the State has undertaken the publication of such proceedings, the Academy will, upon request of the Governor, or of one of the several departments of the State, through the Governor, act through its council as an advisory body in the direction and execution of any investigation within its province as stated. The necessary expenses incurred in the prosecution of such investigation are to be borne by the State; no pecuniary gain is to come to the Academy for its advice or direction of such investigation.

The regular proceedings of the Academy as published by the State shall become a public document.

ARTICLE II.

SECTION 1. Members of this Academy shall be honorary fellows, fellows, non-resident members or active members.

SEC. 2. Any person engaged in any department of scientific work, or in original research in any department of science, shall be eligible to active membership. Active members may be annual or life members. Annual members may be elected at any meeting of the Academy; they shall sign the constitution, pay an admission fee of two dollars,

and thereafter an annual fee of one dollar. Any person who shall at one time contribute fifty dollars to the funds of this Academy may be elected a life member of the Academy, free of assessment. Non-resident members may be elected from those who have been active members but who have removed from the State. In any case, a three-fourths vote of the members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on application for membership, who shall consider such application and report to the Academy before the election.

SEC. 3. The members who are actively engaged in scientific work, who have recognized standing as scientific men, and who have been members of the Academy at least one year, may be recommended for nomination for election as fellows by three fellows or members personally acquainted with their work and character. Of members so nominated a number not exceeding five in one year may, on recommendation of the Executive Committee, be elected as fellows. At the meeting at which this is adopted, the members of the Executive Committee for 1894 and fifteen others shall be elected fellows, and those now honorary members shall become honorary fellows. Honorary fellows may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case a three-fourths vote of the members present shall elect.

ARTICLE III.

SECTION 1. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall hold office one year. They shall consist of a President, Vice-President, Secretary, Assistant Secretary, Press Secretary, and Treasurer, who shall perform the duties usually pertaining to their respective offices and in addition, with the ex-Presidents of the Academy, shall constitute an Executive Committee. The President shall, at each annual meeting, appoint two members to be a committee which shall prepare the programs and have charge of the arrangements for all meetings for one year.

SEC. 2. The annual meeting of this Academy shall be held in the city of Indianapolis within the week following Christmas of each year, unless otherwise ordered by the Executive Committee. There shall

also be a summer meeting at such time and place as may be decided upon by the Executive Committee. Other meetings may be called at the discretion of the Executive Committee. The past Presidents, together with the officers and Executive Committee, shall constitute the Council of the Academy, and represent it in the transaction of any necessary business not specially provided for in this constitution, in the interim between general meetings.

SEC. 3. This constitution may be altered or amended at any annual meeting by a three-fourths majority of the attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

BY-LAWS.

1. On motion, any special department of science shall be assigned to a curator, whose duty it shall be, with the assistance of the other members interested in the same department, to endeavor to advance knowledge in that particular department. Each curator shall report at such time and place as the Academy shall direct. These reports shall include a brief summary of the progress of the department during the year preceding the presentation of the report.

2. The President shall deliver a public address on the morning of one of the days of the meeting at the expiration of his term of office.

3. The Press Secretary shall attend to the securing of proper newspaper reports of the meetings and assist the Secretary.

4. No special meeting of the Academy shall be held without a notice of the same having been sent to the address of each member at least fifteen days before such meeting.

5. No bill against the Academy shall be paid without an order signed by the President and countersigned by the Secretary.

6. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the Treasurer, shall have their names stricken from the roll.

7. Ten members shall constitute a quorum for the transaction of business.

MEMBERS.

FELLOWS.

R. J. Aley	*1898	Bloomington.
Frank M. Andrews	1904	Bloomington.
J. C. Arthur	1893	Lafayette.
George W. Benton	1896	Indianapolis.
A. J. Bigney	1897	Moore's Hill.
A. W. Bitting	1897	West Lafayette.
Donaldson Bodine	1899	Crawfordsville.
W. S. Blatchley	1893	Indianapolis.
H. L. Bruner	1899	Irvington.
Severance Burrage	1898	Lafayette.
A. W. Butler	1893	Indianapolis.
J. L. Campbell**	1893	Crawfordsville.
Mel. T. Cook	1902	Santiago, Cuba.
John M. Coulter	1893	Chicago, Ill.
Stanley Coulter	1893	Lafayette.
Glenn Culbertson	1899	Hanover.
D. W. Dennis	1895	Richmond.
C. R. Dryer	1897	Terre Haute.
C. H. Eigenmann	1893	Bloomington.
Percy Norton Evans	1901	West Lafayette.
A. L. Foley	1897	Bloomington.
Katherine E. Golden	1895	Lafayette.
M. J. Golden	1899	Lafayette.
W. F. M. Goss	1893	Lafayette.
Thomas Gray	1893	Terre Haute.
A. S. Hathaway	1895	Terre Haute.
W. K. Hatt	1902	Lafayette.
Robert Hessler	1899	Logansport.
H. A. Huston	1893	Lafayette.
Edwin S. Johannott	1904	Terre Haute.
Arthur Kendrick	1898	Terre Haute.
Robert E. Lyons	1896	Bloomington.
W. A. McBeth	1904	Terre Haute.

*Date of election.
**Deceased.

V. F. Marsters	1893	Bloomington.
C. L. Mees	1894	Terre Haute.
J. A. Miller	1904	Bloomington.
W. J. Moenkhaus	1901	Bloomington.
Joseph Moore	*1896	Richmond.
D. M. Mottier	1893	Bloomington.
J. P. Naylor	1903	Greencastle.
W. A. Noyes	1893	Washington, D. C.
J. H. Ransom	1902	Lafayette.
L. J. Rettger	1896	Terre Haute.
J. T. Scovell	1894	Terre Haute.
Alex Smith	1893	Chicago, Ill.
W. E. Stone	1893	Lafayette.
Joseph Swain	1898	Swarthmore, Pa.
M. B. Thomas	1893	Crawfordsville.
C. A. Waldo	1893	Lafayette.
F. M. Webster	1894	Champaign, Ill.
Jacob Westlund	1904	Lafayette.
H. W. Wiley	1895	Washington, D. C.
John S. Wright	1894	Indianapolis.

NON-RESIDENT MEMBERS.

George H. Ashley	Charleston, S. C.
M. A. Brannon	Grand Forks, N. D.
J. C. Branner	Stanford University, Cal.
D. H. Campbell	Stanford University, Cal.
A. Wilmer Duff	Worcester, Mass.
B. W. Everman	Washington, D. C.
Charles H. Gilbert	Stanford University, Cal.
C. W. Green	Stanford University, Cal.
C. W. Hargitt	Syracuse, N. Y.
O. P. Hay	New York City.
Edward Hughes	Stockton, Cal.
O. P. Jenkins	Stanford University, Cal.
D. S. Jordan	Stanford University, Cal.
J. S. Kingsley	Tufts College, Mass.

*Date of election.

D. T. MacDougal.....Bronx Park, New York City.
T. C. Mendenhall.....Worcester, Mass.
Alfred Springer.....Cincinnati, Ohio.
L. M. Underwood.....New York City.
Robert B. Warder.....Washington, D. C.
Ernest Walker.....Clemson College, S. C.

ACTIVE MEMBERS.

George Abbott.....Indianapolis.
George C. Ashman.....Frankfort.
Edward Ayres.....Lafayette.
Edward Hugh Bangs.....Indianapolis.
Walter D. Baker.....Indianapolis.
Arthur M. Banta.....Franklin.
J. W. Beede.....Bloomington.
William N. Blanchard.....Greencastle.
Edwin M. Blake.....Lafayette.
Lee F. Bennett.....Valparaiso.
Charles S. Bond.....Richmond.
Fred. J. Breeze.....Delphi.
E. M. Bruce.....Weston, Oregon.
Herman S. Chamberlain.....Indianapolis.
E. J. Chansler.....Bicknell.
Otto O. Clayton.....Geneva.
Howard W. Clark.....Chicago, Ill.
George Clements.....Crawfordsville.
Charles Clickener.....Silverwood, R. D. No. 1.
U. O. Cox.....Mankato, Minn.
William Clifford Cox.....Columbus.
J. A. Cragwall.....Crawfordsville.
Albert B. Crow.....Charleston, Ill.
M. E. Crowell.....Franklin.
Edward Roscoe Cumings.....Bloomington.
Alida M. Cunningham.....Alexandria.
Lorenzo E. Daniels.....Indianapolis.
H. J. Davidson.....Baltimore, Md.
Charles C. Deam.....Bluffton.

Martha Doan	Westfield.
J. P. Dolan	Syracuse.
Herman B. Dorner	Lafayette.
Hans Duden	Indianapolis.
Frank R. Eldred	Indianapolis.
M. N. Elrod	Columbus.
Samuel G. Evans	Evansville.
Carlton G. Ferris	Big Rapids, Mich.
E. M. Fisher	Urmeyville.
Wilbur A. Fiske	Richmond.
W. B. Fletcher	Indianapolis.
Austin Funk	New Albany.
John D. Gabel	Montpelier.
Charles W. Garrett	Logansport.
Robert G. Gillum	Terre Haute.
Vernon Gould	Rochester.
Walter L. Hahn	Bascom.
Victor Hendricks	Indianapolis.
Mary A. Hickman	Greencastle.
John E. Higdon	Indianapolis.
Frank R. Higgins	Terre Haute.
S. Bella Hilands	Madison.
John J. Hildebrandt	Logansport.
J. D. Hoffman	Lafayette.
Allen D. Hole	Richmond.
Lucius M. Hubbard	South Bend.
John N. Hurty	Indianapolis.
C. F. Jackson	Greencastle.
Alex. Johnson	Ft. Wayne.
Ernest E. Jones	Kokomo.
Wm. J. Jones, Jr	West Lafayette.
Chancey Juday	Boulder, Colo.
O. L. Kelso	Terre Haute.
Norton A. Kent	Crawfordsville.
Charles T. Knipp	Champaign, Ill.
Henry H. Lane	Lebanon.
William E. Lawrence	Richmond.
V. H. Lockwood	Indianapolis.

Robert Wesley McBride.....Indianapolis.
Rousseau McClellan .....Indianapolis.
Richard C. McClaskey.....Terre Haute.
Lynn B. McMullen.....Indianapolis.
Edward G. Mahin.....West Lafayette.
James E. Manchester.....Vincennes.
Clark Mick .....Indianapolis.
W. G. Middleton.....Richmond.
H. T. Montgomery .....South Bend.
Walter P. Morgan.....Terre Haute.
Fred Mutchler .....Terre Haute.
Charles E. Newlin.....Irvington.
John Newlin .....West Lafayette.
John F. Newsom.....Stanford University, Cal.
R. W. Noble .....Chicago, Ill.
D. A. Owen .....Franklin.
Rollo J. Peirce.....Indianapolis.
Ralph B. Polk.....Greenwood.
James A. Price.....Ft. Wayne.
Frank A. Preston.....Indianapolis.
A. H. Purdue.....Fayetteville, Ark.
Rolla R. Ramsey.....Bloomington.
Ryland Ratliff .....Danville.
Albert B. Reagan .....Marietta, Wash.
Allen J. Reynolds.....Peru.
Giles E. Ripley .....Decorah, Iowa.
George L. Roberts.....Greensburg.
D. A. Rothrock.....Bloomington.
John F. Schnaible.....Lafayette.
E. A. Schultze.....Ft. Wayne.
John W. Shepherd .....Terre Haute.
Claude Siebenthal.....Indianapolis.
J. R. Slonaker.....Madison, Wis.
C. Piper Smith.....Leland Stanford, Cal.
Retta E. Spears .....Elkhart.
J. M. Stoddard.....Indianapolis.
Charles F. Stegmaier .....Greensburg.
William Stewart .....Burlington, Vt.

William B. Streeter	Indianapolis.
Frank B. Taylor	Ft. Wayne.
J. F. Thompson	Richmond.
C. H. Underwood	Indianapolis.
A. L. Treadwell	Oxford, Ohio.
Daniel J. Troyer	Goshen.
A. B. Ulrey	North Manchester.
W. B. Van Gorder	Worthington.
Arthur C. Veatch	Rockport.
H. S. Voorhees	Ft. Wayne.
J. H. Voris	Huntington.
Frank B. Wade	Indianapolis.
Daniel T. Weir	Indianapolis.
B. C. Waldemaier	West Lafayette.
Fred C. Whitcomb	Delphi.
William M. Whitten	South Bend.
Neil H. Williams	Terre Haute.
William Watson Woollen	Indianapolis.
J. F. Woolsey	Indianapolis.
Lucy Youse	Terre Haute.
Charles Zeleny	Bloomington.

Fellows	53
Non-resident members	20
Active members	126
Total	199

LIST OF FOREIGN CORRESPONDENTS.

AFRICA.

Dr. J. Medley Wood, Natal Botanical Gardens, Berea Durban, South Africa.

South African Philosophical Society, Cape Town, South Africa.

ASIA.

China Branch Royal Asiatic Society, Shanghai, China.

Asiatic Society of Bengal, Calcutta, India.

Geological Survey of India, Calcutta, India.

Indian Museum of India, Calcutta, India.

India Survey Department of India, Calcutta, India.

Deutsche Gesellschaft, für Natur- und Völkerkunde Ostasiens, Tokio, Japan.

Imperial University, Tokio, Japan.

Koninklijke Naturkundige Vereeniging in Nederlandsch-Indie, Batavia, Java.

Hon. D. D. Baldwin, Honolulu, Hawaiian Islands.

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Herman von Vilas, Innsbruck, Austria.

Ethnologische Mittheilungen aus Ungarn, Budapest, Austro-Hungary.

Mathematische und Naturwissenschaftliche Berichte aus Ungarn, Budapest, Austro-Hungary.

K. K. Geologische Reichsanstalt, Vienna (Wien), Austro-Hungary.

K. U. Naturwissenschaftliche Gesellschaft, Budapest, Austro-Hungary.

Naturwissenschaftlich-Medizinischer Verein in Innsbruck (Tyrol), Austro-Hungary.

Editors "Termeszetrajzi Fuzetk," Hungarian National Museum, Budapest, Austro-Hungary.

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Dr. Julius von Madarasz, Budapest, Austro-Hungary.
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Ornithological Society of Vienna (Wien), Austro-Hungary.
Zoölogische-Botanische Gesellschaft in Wien (Vienna), Austro-Hungary.
Dr. J. von Csato, Nagy Enyed, Austro-Hungary.
Botanic Garden, K. K. Universität, Wien (Vienna), Austro-Hungary.

Malacological Society of Belgium, Brussels, Belgium.
Royal Academy of Science, Letters and Fine Arts, Brussels, Belgium.
Royal Linnean Society, Brussels, Belgium.
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Societé Royale de Botanique, Brussels, Belgium.
Societé Geologique de Belgique, Liège, Belgium.
Royal Botanical Gardens, Brussels, Belgium.

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Geological Society of London, London, England.
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Liverpool Geological Society, Liverpool, England.
Manchester Literary and Philosophical Society, Manchester, England.
"Nature," London, England.
Royal Botanical Society, London, England.
Royal Kew Gardens, London, England.
Royal Geological Society of Cornwall, Penzance, England.
Royal Microscopical Society, London, England.
Zoölogical Society, London, England.
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Societé Entomologique de France, Paris, France.
L'Institut Grand Ducal de Luxembourg, Luxembourg, Lux., France.
Soc. de Horticulture et de Botan. de Marseille, Marseilles, France.
La Soc. Linneenne de Normandie, Caen, France.
Societé Linneenne de Bordeaux, Bordeaux, France.
Soc. des Naturelles, etc., Nantes, France.
Zoölogical Society of France, Paris, France.
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Count Hans von Berlspen, Münden, Germany.
Braunschweiger Verein für Naturwissenschaft, Braunschweig, Germany.
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Royal Botanical Gardens, Berlin W., Germany.
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Königlich-Sächsische Gesellschaft der Wissenschaften, Mathematisch-Physische Classe, Leipzig, Saxony, Germany.
Naturhistorische Gesellschaft zu Hanover, Hanover, Prussia, Germany.
Naturwissenschaftlicher Verein in Hamburg, Hamburg, Germany.
Verein für Erdkunde, Leipzig, Germany.
Verein für Naturkunde, Wiesbaden, Prussia.

Belfast Natural History and Philosophical Society, Belfast, Ireland.
Royal Dublin Society, Dublin.
Royal Botanic Gardens, Glasnevin, County Dublin, Ireland.

Societa Entomologica Italiana, Florence, Italy.
Prof. H. H. Giglioli, Museum Vertebrate Zoölogy, Florence, Italy.
Dr. Alberto Perngia, Museo Civico di Storia Naturale, Genoa, Italy.
Societa Italiana de Scienze Naturali, Milan, Italy.
Societa Africana d'Italia, Naples, Italy.
Dell' Academia Pontifico de Nuovi Lincei, Rome, Italy.
Minister of Agriculture, Industry and Commerce, Rome, Italy.
Rassegna della Scienze Geologiche in Italia, Rome, Italy.
R. Comitato Geologico d'Italia, Rome, Italy.
Prof. Count Tomasso Salvadori, Zoölog. Museum, Turin, Italy.

Royal Norwegian Society of Sciences, Throndhjem, Norway.
Dr. Robert Collett, Kongl. Frederiks Univ. Christiana, Norway.

Academia Real des Sciencias de Lisboa (Lisbon), Portugal.
Comité Geologique de Russie, St. Petersburg, Russia.
Imperial Academy of Sciences, St. Petersburg, Russia.
Imperial Society of Naturalists, Moscow, Russia.
Jardin Imperial de Botanique, St. Petersburg, Russia.
The Botanical Society of Edinburgh, Edinburgh, Scotland.
John J. Dalgleish, Brankston Grange, Bogside Sta., Sterling, Scotland.
Edinburgh Geological Society, Edinburgh, Scotland.
Geological Society of Glasgow, Scotland.
John A. Harvie-Brown, Duniplace House, Larbert, Stirlingshire, Scotland.
Natural History Society, Glasgow, Scotland.
Philosophical Society of Glasgow, Glasgow, Scotland.
Royal Society of Edinburgh, Edinburgh, Scotland.
Royal Physical Society, Edinburgh, Scotland.
Royal Botanic Garden, Edinburgh, Scotland.

Barcelona Academia de Ciencias y Artes, Barcelona, Spain.
Royal Academy of Sciences, Madrid, Spain.

Institut Royal Geologique de Suède, Stockholm, Sweden.
Societé Entomologique a Stockholm, Stockholm, Sweden.
Royal Swedish Academy of Science, Stockholm, Sweden.

Naturforschende Gesellschaft, Basel, Switzerland.
Naturforschende Gesellschaft in Berne, Berne, Switzerland.
La Societé Bontanique Suisse, Geneva, Switzerland.
Societé Helvetique de Sciences Naturelles, Geneva, Switzerland.
Societé de Physique et d'Historie Naturelle de Geneva, Geneva, Switzerland.
Concilium Bibliographicum, Zürich-Oberstrasse, Switzerland.
Naturforschende Gesellschaft, Zürich, Switzerland.
Schweizerische Botanische Gesellschaft, Zürich, Switzerland.
Prof. Herbert H. Field, Zürich, Switzerland.

AUSTRALIA.

Linnean Society of New South Wales, Sidney, New South Wales.
Royal Society of New South Wales, Sidney, New South Wales.
Prof. Liveridge, F. R. S., Sidney, New South Wales.
Hon. Minister of Mines, Sidney, New South Wales.
Mr. E. P. Ramsey, Sidney, New South Wales.
Royal Society of Queensland, Brisbane, Queensland.
Royal Society of South Australia, Adelaide, South Australia.
Victoria Pub. Library, Museum and Nat. Gallery, Melbourne, Victoria.
Prof. W. L. Buller, Wellington, New Zealand.

NORTH AMERICA.

Natural Hist. Society of British Columbia, Victoria, British Columbia.
Canadian Record of Science, Montreal, Canada.
McGill University, Montreal, Canada.
Natural Society, Montreal, Canada.
Natural History Society, St. Johns, New Brunswick.
Nova Scotia Institute of Science, Halifax, N. S.
Manitoba Historical and Scientific Society, Winnipeg, Manitoba.
Dr. T. McIlwraith, Cairnbrae, Hamilton, Ontaria.
The Royal Society of Canada, Ottawa, Ontario.
Natural History Society, Toronto, Ontario.
Hamilton Association Library, Hamilton, Ontario.
Canadian Entomologist, Ottawa, Ontario.
Department of Marine and Fisheries, Ottawa, Ontario.
Ontario Agricultural College, Guelph, Ontario.

Canadian Institute, Toronto.
Ottawa Field Naturalists' Club, Ottawa, Ontario.
University of Toronto, Toronto.
Geological Survey of Canada, Ottawa, Ontario.
La Naturaliste Canadian, Chicontini, Quebec.

La Naturale Za, City of Mexico.
Mexican Society of Natural History, City of Mexico.
Museo Nacional, City of Mexico.
Sociedad Cientifica Antonio Alzate, City of Mexico.
Sociedad Mexicana de Geographia y Estadistica de la Republica Mexicana, City of Mexico.

WEST INDIES.

Botanical Department, Port of Spain, Trinidad, British West Indies.
Victoria Institute, Trinidad, British West Indies.
Museo Nacional, San Jose, Costa Rica, Central America.
Dr. Anastasia Alfaro, Secy. National Museum, San Jose, Costa Rica.
Rafael Arango, Havana, Cuba.
Jamaica Institute, Kingston, Jamaica, West Indies.
The Hope Gardens, Kingston, Jamaica, West Indies.
Estacion Central Agronomica Departmento de Patologia, Santiago de las Vegas, Cuba.

SOUTH AMERICA.

Argentina Historia Natural Florentine Amegline, Buenos Ayres, Argentine Republic.
Musée de la Plata, Argentine Republic.
Nacional Academia des Ciencias, Cordoba, Argentine Republic.
Sociedad Cientifica Argentine, Buenos Ayres.
Museo Nacional, Rio de Janeiro, Brazil.
Sociedad de Geographia, Rio de Janeiro, Brazil.
Dr. Herman von Jhering, Dir. Zoöl. Sec. Con. Geog. e Geol. de Sao Paulo, Rio Grande do Sul, Brazil.

Deutscher Wissenschaftlicher Verein in Santiago, Santiago, Chili.
Societé Scientifique du Chili, Santiago, Chili.
Sociedad Guatemalteca de Ciencias, Guatemala, Guatemala.

PROGRAM

OF THE

TWENTIETH ANNUAL MEETING

OF THE

INDIANA ACADEMY OF SCIENCE,

SHORTRIDGE HIGH SCHOOL, INDIANAPOLIS.

November 25, 1904.

OFFICERS AND EX-OFFICIO EXECUTIVE COMMITTEE.

CARL L. MEES, President.
GLENN CULBERTSON, Vice-President.
JOHN S. WRIGHT, Secretary.
J. H. RANSOM, Assistant Secretary.
G. A. ABBOTT, Press Secretary.
W. A. McBETH, Treasurer.

W. S. BLATCHLEY,
H. W. WILEY,
M. B. THOMAS,
D. W. DENNIS,
C. H. EIGENMANN,
C. A. WALDO,
THOMAS GRAY,
STANLEY COULTER,
AMOS W. BUTLER,
W. A. NOYES,
J. C. ARTHUR,
J. L. CAMPBELL,
O. P. HAY,
T. C. MENDENHALL,
JOHN C. BRANNER,
J. P. D. JOHN,
JOHN M. COULTER,
DAVID S. JORDAN.

The sessions of the Academy will be held in the Shortridge High School. The President's address will be given in the auditorium of the Shortridge High School.

Headquarters will be at the English Hotel. A rate of $2.00 and up per day, American plan, will be made to all persons who make it known at the time of registering that they are members of the Academy.

Reduced railroad rates for the members can not be secured under the present ruling of the Traffic Association. Many of the colleges can secure special rates on the various roads.

PROGRAM COMMITTEE.

GEORGE W. BENTON, Indianapolis. JOHN S. WRIGHT, Indianapolis.
KATHERINE E. GOLDEN, Lafayette.

GENERAL PROGRAM.

THURSDAY, NOVEMBER 24.

Meeting of Executive Committee at Hotel Headquarters..... 8:00 p. m.

FRIDAY, NOVEMBER 25.

General Session..... 9:00 a. m.
President's Address..... 11:00 a. m.
General Session, followed by Sectional Meetings..... 2:00 p. m.

LIST OF PAPERS TO BE READ.

ADDRESS BY THE RETIRING PRESIDENT,

CARL L. MEES,

At 11 o'clock Friday morning, at Shortridge High School.

Subject: "Electricity and Matter; Recent Developments."

The following papers will be read in the order in which they appear on the program, except that certain papers will be presented "*pari passu*" in sectional meetings. When a paper is called and the reader is not present, it will be dropped to the end of the list, unless by mutual agreement an exchange can be made with another whose time is approximately the same. Where no time was sent with the papers, they have been uniformly assigned ten minutes. Opportunity will be given after the reading of each paper for a brief discussion.

N. B.—By the order of the Academy, no paper can be read until an abstract of its contents or the written paper has been placed in the hands of the Secretary.

GENERAL.

1. City Dust--Cause and Effect, 15 m.....Robert Hessler
2. Old Water Power Mills of Carroll County, 10 m.....Fred J. Breese
3. Photography for the Nature Student (illustrated by the stereopticon), 20 m. Benjamin W. Douglass

**4. The Rosebud Indian Celebration, 10 m..... Albert B. Reagan

PHYSICS, MATHEMATICS, ASTRONOMY AND PHYSIOGRAPHY.

5. A Device for Determining the Period of a Pendulum, 5 m.....Herman S. Chamberlain
6. Some Experiments with a Simple Jolly Balance, 10 m.....Lynn B. McMullen
7. "N"-Rays, 15 m.....Rolla R. Ramsey and W. P. Haseman
8. Electro-Magnetic Induction in Different Conductors, 10 m. Arthur L. Foley and C. A. Evans
9. Interference Fringes from the Path of an Electric Discharge, 5 m. Arthur L. Foley and J. H. Haseman
10. On the Deformation of Surfaces Referred to a Conjugate System of Lines, 10 m. Burke Smith
11. Warped Surfaces with two Distinct Rectilinear Directrices, 10 m.....C. A. Waldo
12. A New Form of Mathematical Models, 10 m .....C. A. Waldo
13. Measures of Some Neglected Pairs of Double Stars, 5 m .....John A. Miller
14. An Esker in Tippecanoe County, Indiana, 10 m.....W. A. McBeth
15. Notes on the Mississippi Delta, 15 m .....W. A. McBeth

15*a*. The Newtonian Idea of the Calculus, 20 m.....A. S. Hathaway

ETHNOLOGY.

*16. The Cliff Dwellers of Arizona, 10 m ..... Albert B. Reagan
17. All Saints' Day at Jemez, New Mexico, 10 m ..... Albert B. Reagan
18. The Penitenties, 10 m ..... Albert B. Reagan
19. The Matachina Dance, 10 m ..... Albert B. Reagan
20. The Moccasin Game, 10 m ..... Albert B. Reagan
21. The Apache Medicine Game, 10 m ..... Albert B. Reagan
22. The Apache Ceremonies Performed Over the Daughter of C 30, 10 m. Albert B. Reagan

BOTANY AND ZOÖLOGY.

**23. A Heronry near Rushville, Indiana, 5 m ..... D. W. Dennis
*24. Notes from the Indiana State Forestry Reservation, 10 m ..... Charles Piper Smith
*25. Notes Upon Some Little Known Members of the Indiana Flora, 10 m. Charles Piper Smith
**26. Pollination of Campanula Americana, 3 m ..... Moses N. Elrod
27. Additions to the Indiana Flora, 5 m ..... Charles C. Deam
28. Physiological Apparatus for Botany, 10 m ..... Frank M. Andrews
29. On the Nomenclature of Fungi Having Many Fruit Forms, 15 m ..... J. C. Arthur
30. Amphispores of the Grass and Sedge Rusts, 15 m ..... J. C. Arthur
31. Preliminary Notes on the North American Species of the Genus Cuscuta (by abstract), 10 m ..... Stanley Coulter
32. The Poisonous Plants of Indiana, 10 m ..... Stanley Coulter
33. Birds and Fruits, 10 m ..... A. W. Butler
34. The Sclerenchymatous Tyloses in Brosimum Aubletii, 10 m ..... Katherine E. Golden
35. The Effect of Environment on the Action of Cytase, 10 m ..... Katherine E. Golden
36. Additions to the Flora of Marion County, Indiana, 3 m ..... Benjamin W. Douglass
**37. Additions to the List of Gall Producing Insects, common to Indiana (abstract), 5 m ..... Mel T. Cook

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*Not presented.
**By title.

EDITORIAL NOTICE.

All members of the Academy will doubtless be ready to assist in any efforts put forth having in view correct and early publications of the Proceedings. To this end the following conditions of publication are announced by the editor:

1. All papers to be included in the report of 1904 must be in the hands of the editor not later than December 10, 1904.
2. All papers should be typewritten as far as the nature of the subject will allow.
3. All tracings and maps should be drawn to correspond with the size of the page of the Proceedings, and must come within the following limits: 4¼x7 inches. If necessary it may be made to cover two pages, or measure 8½x11 inches.
4. Authors are especially requested to carefully mark and number all illustrations, and to carefully indicate in the MSS. the exact location of such illustrations.
5. To insure proper representation of mathematical work, authors are particularly cautioned to send in carefully traced figures on separate paper.
6. The limits of the appropriation require that all illustrations shall be in one color, and either photographs or etchings. As a consequence, all illustrations must be in black and white.

THE TWENTIETH ANNUAL MEETING OF THE INDIANA ACADEMY OF SCIENCE.

The twentieth annual meeting of the Indiana Academy of Science was held in Indianapolis, Thursday and Friday, November 24 and 25, 1904.

Thursday at 8 p. m. the Executive Committee met in session at hotel headquarters.

President Carl L. Mees, at 9 a. m. Friday, called the Academy to order in general session in the assembly hall of the Shortridge High School. The transaction of routine and miscellaneous business occupied the attention of the Academy until 11 a. m., when the retiring President, Carl L. Mees, delivered an address upon: "Electricity and Matter; Recent Developments." Following this address came an adjournment until 2 p. m., when papers of general interest were presented before the Academy as a whole. From 3:30 to 5 p. m., the time for adjournment, sectional meetings were held.

THE SPRING MEETING OF 1904.

The spring meeting of 1904 was held at Indianapolis, Thursday and Friday, April 28 and 29.

On Thursday evening an informal meeting was arranged at the Commercial Club. The principal topic for discussion was the interference of the Academy's set date of meeting with the dates usually chosen by the American Association for the Advancement of Science. The point was finally settled by making the date of the 1904 winter meeting November 24 and 25.

Friday morning most of the members of the Academy attended the meetings of the Indiana Science Teachers' Association.

Friday noon the Indianapolis members were the hosts at a luncheon at the Commercial Club.

Later various excursions were enjoyed by various members, some visiting the Kingan packing plant, others the Central Hospital for the Insane, and still other enthusiasts tramped over the country north and northeast of Indianapolis, under the leadership of W. S. Blatchley, studying the geological and botanical features of that district.

City Dust—Cause and Effect.

Robert Hessler.

This paper is in line with one read a year ago on "Cold and Colds" and is really a continuation of the same subject. The influence of dust on the health of man is, however, such a vast one that in a brief paper like this only one or two phases can be taken up.

In a general way we can say that dust is a product and an accompaniment of civilization. There are of course special kinds of dust with whose production man has nothing to do, such as the dust of sandy deserts, volcanic dust, and the dust arising along the trails of animals going to salt licks, etc., but in a general way the terms dust and man go together. Dust is solid matter in a state of fine division, so fine that it can be wafted or blown about by the wind. Among primitive people there is little dust, their mode of life forbids its formation and their nomadic or out of door existence prevents its accumulation.

Paradoxical as it may seem, the amount of dust in a modern city is not an index of a high degree of civilization, no more than is the presence of dirt and filth or its accumulation in a house an index of a high social standing of a family.

In a general way it may be said that accumulation of dust in a city is the result of the ignorance of common sanitary laws, of apathy on the part of the citizens, and of bad politics in those having the management of municipal affairs. A housewife who allows dust to accumulate is said to be slovenly; a tidy housekeeper is one who gets rid of the dust as soon as possible and does not allow it to accumulate. We have not yet reached a point where we can make similar distinctions between cities—we simply speak of one place being less dirty than another.

Cosmopolitan travelers tell us how clean some people and their cities are and how the streets correspond with the interior of their houses. The Japanese and the Dutch seem to stand at the head of the list, but I have no doubt that in the course of time other nations will reach the same standard of cleanliness, and, I may add, of general health.

Kinds of Dust: Confining ourselves to the kinds of dust due to the activity of man and disregarding special or rare kinds, such as factory dust, for instance, we can in a general way distinguish two kinds.

1. Common country road dust, due to the attrition of solid matter—the hoofs of the horse and the wheels of the vehicle on the road material, the stone or gravel or merely the common dirt. This kind of dust is mixed with only a small amount of other, vegetable, matter, the droppings of horses chiefly. From a sanitary standpoint it is not very objectionable, although it may be so esthetically.

2. City dust, the dust of the sanitarian, the dust par excellence. City dust has a complex composition. Most of it comes from the droppings of horses and originally existed in the form of hay, oats and corn. The fineness of the particles depends on the length of time it remains on the street to be pulverized by traffic. The wear of the street paving material under the horse's hoof and of vehicles adds an appreciable amount; more is added by litter falling from passing wagons, or is brought in from the mud roads adhering to the wheels. Soot, due to the imperfect combustion of coal, lends character to the city dust and in our American cities there is much of it, especially during the cold season of the year. Man himself adds not a little directly: the wear and tear of clothing and the shedding of epidermal scales adds a minute quantity—and much comes from his mouth, in the form of tobacco juice, saliva, and the abnormal secretions due to an unhealthy condition of the mucous membranes. City dust acquires peculiar properties on this account and thus making it differ radically from all other forms of dust.

More might be said on the causation of dust, but much more can be said concerning its influence or effects, and to this I will now turn.

Effects of Dust: The most noticeable effect of city dust is that it makes a city, its houses and inhabitants, look dirty. The dust is blown all about and settles over everything, indoors and out, and the housewife is kept busy trying to keep things looking clean.

There is an old saying about an ill wind that blows nobody good. The laundryman flourishes in a dusty city, clean linen means frequent laundering. The doctor flourishes because dust means sickness and disease. "There is good money in that for me," a physician remarked, as a dense cloud of dust was seen coming down the street. But the individual, par excellence, benefited is the patent medicine man; he flourishes exceedingly in a dusty city and his nostrums are in great demand.

Now this brings up a phase of city life and of the city dust question that is rarely considered. The scientist who has no medical education and no practical experience with ailments and diseases can not

fully realize the importance of the subject, while, on the other hand, the average physician pays too little attention to the scientific but non-medical aspects of it. As a matter of fact most physicians are so disgusted with the subject, and patent medicines are in such bad repute with them, that they think it beneath their dignity to notice it—and so the patent medicine man flourishes unmolested.

But, it will be argued, if the patent medicine man flourishes that is evidence that his wares are in demand; if there were no demand he would not flourish. Of course. The law of demand and supply might be quoted. It might also be said that reading maketh a full man—but that hardly applies to the reader of the patent medicine advertisements in the newspapers.

Consulting the Literature: Every worker in science knows what it means to look up the literature of a subject. "Consulting the literature," is a common expression. Now when it comes to the kind of literature just referred to we need not look far nor long to find it. The very first newspaper or magazine you get hold of will be full of it. Did you ever examine, not to say study, such advertisements? Can it be said of the man who does not and can not read that he is keeping back the progress of his race in its attempts to solve the problems that are constantly arising as man gets farther and farther away from the condition of primitive man? The man who reads patent medicine literature for the purpose of getting valuable or useful information is certainly to be pitied.

In a general way patent medicines and the names of common ailments, not to say diseases, go together; the one presupposes the other. Ailments and diseases fall into groups, likewise do patent medicines and their advertisements. If it can be shown that in some of our dusty cities in which the spitting habit prevails three-fourths of the patent medicines are advertised for ailments directly due to the inhalation of city dust, we at once see the importance of the question of pure and impure air and we dimly realize the effects of the dust.

We all know that life depends on the oxidation of organic substances used as food, enabling us to keep up bodily activities. Oxidation means the use of air. Pure air is an important factor in determining health; very impure air can not sustain life and partially impure air may place the body at a disadvantage in the struggle with its surroundings.

Individually susceptibility to impure air differs widely. When impure air is badly borne and bodily functioning is not carried on normally, we speak of ill-health and disease. Disease may result from the use of bad air, and in a general way, bad air means air contaminated by dust, as already mentioned.

Ailments and diseases have a cause, just like all other phenomena in this world. Some diseases are due to parasites, the preying of one form of life upon another. Some forms of life flourish only at the expense of human beings and are constantly transferred from one person to another. Some diseases and their causes are always among us, such as consumption and malaria; others come and go, as cholera and yellow fever. Some diseases are transferred mainly through the drinking water, as typhoid fever and cholera; other diseases are propagated by the bite of the mosquito, as yellow fever and malaria. Some diseases are transmitted through the agency of dust, and hence we speak of air-borne diseases, like tuberculosis, pneumonia, bronchitis and the like.

Some diseases are well defined and can be readily diagnosed, such as those just mentioned; others are obscure and their causes ill-defined. In a general way it may be said that the names of diseases and ailments in common use are names of ill-defined application, that is, there is nothing definite about them, and they are not used in the best medical literature of today. The words "cold," "biliousness," "catarrh," "rheumatism," and the like, do not express anything definite.

Air-borne diseases like tuberculosis and pneumonia are known as specific diseases due to a definite cause; if the cause is absent then the effect, the disease, will also be absent. Ailments are minor affections and are not always due to some one definite cause: headache or a pain in the arm are ailments and may arise from a variety of causes.

It is scarcely necessary to make any specific reference to the science of bacteriology—which concerns itself with what are popularly known as "germs," or to the number of established facts which it embraces. Anyone arguing in opposition to bacteria as a cause of diseases will not even get a respectful hearing from a qualified bacteriologist—it seems to him a waste of time. A man might as well deny the theory of universal gravitation as to deny the germ theory of disease.

Ailments Due to Infected Dust: Inhaling city dust may bring on a variety of ailments, as well as definite diseases. City residents may complain of various pains and aches during or after the prevalence of a dust

storm or after having been confined to a room or hall with a dusty atmosphere, and country people may complain of not feeling well every time they come from a trip to the dusty city or take a ride on a dusty railway car. Although the effects of inhaling a bad atmosphere or dust differ somewhat in different individuals, yet by observing certain individuals for a long time, and observing a great many now and then, we may be able to draw some conclusions with a reasonable degree of accuracy.

In a general way it may be said that when the air is free from sputum or expectoration, certain ailments and diseases are also absent. The Japanese are remarkably free from ailments that are very common among us: The Japanese do not spit and they also have clean homes. North pole explorers and weather observers on high mountains are free from colds, catarrh, rheumatic aches and pains, bronchitis, and a host of other ailments and diseases—simply because the air is pure and the active causes are absent.

The inhalation of a sputum contaminated air has been found to produce a definite reaction in man. In some individuals a reaction occurs under even a slight exposure, others may require a severe exposure, some may escape entirely. We know that in some of the epidemic diseases there are always some individuals who escape. The reaction due to inhaling infected air or dust, may be characterized about as follows: There is an irritation of the mucous membranes; vague wandering pains or aches throughout the body, mostly referable to the muscles and ligaments, and at times more strongly localized at some point, as in the back or in an arm; there is a feeling of lassitude or discomfort, rising to severe headache, feverishness, loss of appetite and even vomiting. In some individuals there is cough on account of the unusual irritation of the respiratory mucous membranes; some complain mainly of the nervous symptoms and the inability of applying themselves to any task; in some the wandering or localized pains may predominate.

The above symptoms have been grouped together and the name Dust Disease has been applied to them. When, therefore, we say a man has dust disease, we at once have some definite idea of the nature of his ailment, and of its cause.

As a general rule an attack of dust disease declines and disappears of its own accord in the course of a day or a few days, but in a bad atmosphere it may continue for several weeks. Other diseases, like bron-

chitis, tonsilitis and pneumonia or tuberculosis may follow, and we can never be sure that an attack will pass off lightly.

Now if we study the advertisements of patent medicines in the newspapers we will find that they vary in amount, that is in number and size, being most common in the fall and spring and when the dust is at its maximum, and least common in the summer—when the streets are sprinkled and the sputum is sterilized by the hot rays of the sun. We will moreover find that three-fourths of the names of the ailments, not to speak of diseases, mentioned in the newspaper advertisements are simply synonyms of dust disease and are due to the inhalation of dust. I will give a list: cold, hoarseness, throat trouble, sickening breath, foul breath, catarrh, grip, sore throat, tonsilitis, pleurisy, a stitch in the side, backache, kidney complaint, kidney disease, lumbago, stiff back, lame back, rheumatism, muscular rheumatism, a touch of rheumatism, aching joints, headache, sick headache, nervous headache, neuralgia, nervous prostration, the blues, brain fag, neurasthenia, biliousness, bilious fever, a touch of malaria. All of these names should of course be in quotation marks. We find also the terms dizziness, faintness, irritability, restlessness and sleeplessness given as names of ailments, and faceache and car sickness are mentioned as diseases.

Now I do not mean to say that in every case of ill-health or of sickness, where the above names are applied, the cause is to be traced to the inhalation of infected dust, because something else may be at the bottom of it, but I believe that most cases of such self-diagnosed ailments (and where the afflicted individual calls for an advertised nostrum at the drug store) are simply cases of dust infection. Even stomach and bowel disturbances in many instances come under the same head, that is, caused by the dust—if not by inhalation, then by the dust which settles on food, as the cold victuals of a dusty restaurant or on fruits and vegetables exposed to the dust of the street. As a matter of fact there is a form of dust infection which manifests itself mainly by a disturbance of the gastric mucous membranes, with abundant secretion of mucus and often accompanied by severe vomiting.

Where one symptom, or its location in the body, dominates, it may give character to the ailment and thereby determine its popular name, or its patent medicine name. For instance, if the secretion of mucus or muco-pus is the chief symptom then we have "catarrh;" if the pain in

the back predominates, we hear the words "backache," or "lumbago" or "rheumatism," or even "disease of the kidneys."

One of the peculiarities of the human mind is that the moment a name is given to a thing, to a phenomenon or even a sensation, it is, by many men at least, regarded as a something definite, as an entity. This is especially true in the case of abnormal conditions of the human body. The average man does not regard an ailment simply as a warning from nature that something is wrong and that means should be taken to correct the condition—by removing the cause, but he regards it as an entity that should or must be overcome by an antagonist, an antidote, or in other words a "medicine." Hence a pain calls for a "pain killer" and a cough for a "cough cure." That chronic ill-health and disease may result from such a course is well known to medical men, and that is why they say the more patent medicines the people use the more work there is for the doctors.

With the active cause constantly present, that is infective dust, there are of course many cases of ill-health. Minor ailments make up the great mass of daily complaints of ill-health. There may be simple malaise or lassitude, or well defined aches and pains for which we are not able to account and take them as a matter of course. The relationship between a ride on a dusty street car on the way down town or the confinement to an illy-ventilated, dusty room or an exposure to clouds of street dust, to a subsequent attack of running nose or feverishness, wandering pains and aches or headache or biliousness or loss of appetite, is seldom considered. People have to have their attention called to these things and led to realize that a polluted atmosphere means ill-health and may lead to a well-defined disease.

The Patent Medicine Habit: When a man feels bad he of course wants something to make him feel good or well. Simple means, such as quiet, rest, fasting, good air, may be all that is needed for a day or two to enable nature to bring about a normal condition. But few persons pursue such a course: It is easier to stop in at the drug store and call for one of those widely advertised nostrums guaranteed to "kill the pain" or "stop the cough." Repeated and increased doses may be required, but that does not matter so long as relief follows, and no serious thought is given the matter until nature rebels and a serious disease is the result. Pain in nearly every case is simply a warning that something is wrong,

and a cough in most instances is simply an effort on nature's part to get rid of some irritating material. When we get a particle of food into the windpipe we cough until it comes up, but when the cough is due to the inhalation of a mass of irritating dust particles we (that is, some of us) use a "cough cure."

With the active cause, the infected dust, so plentifully present and with a frequent reaction or effect, that is the presence of an ailment, we have hence another effect: a large variety of nostrums or patent medicines—to counteract the reaction due to inhaling infected dust. In advertising these the long list of names given above is used. Usually some one name is given in large type, followed by several others in smaller type and from time to time there is a shifting, one of the synonyms in the small type will be advanced to head the list. There are several sets of these words or names, depending on the part of the body where the symptoms of the dust infection are mainly localized. If, for instance the pain is mainly in the back, the chief word and the minor ones will likely be: BACKACHE, lumbago, rheumatism, diseases of the kidneys; by changing we get DISEASE OF THE KIDNEYS, backache, lumbago, etc., each of the words being in turn used in large type. For the throat and chest we have: COLD, catarrh, grip, throat trouble, weak lungs, tonsilitis, etc. For the nervous conditions we have words like headache, neuralgia, biliousness, neurasthenia, etc. With a large list of words there can be considerable shifting about. All these points are brought out in the clippings which I will show. The relative amount of space occupied by patent medicine advertisements in the newspapers of different Indiana towns and cities will also be shown by clippings. An examination will show that a minimum of such advertisements in a city means a comparatively clean city, while, on the other hand, in a dirty and dusty city the newspapers are full of advertisements of patent medicines relating to ailments and diseases directly attributable to the inhalation of a dust polluted atmosphere. Nature exacts her dues. What the people save by neglecting to keep their cities clean, they are compelled to spend, or do spend, for patent medicines in the vain attempt to counteract the evil influence of the dust. A comparative study of patent medicine advertisements in the newspapers of different cities, states and nations, furnishes much food for thought. Civic pride and dust seem incompatible. To be able to point with pride to one's home city is quite

different from having to explain to your visiting friend why everything is dirty and dusty.

It would be interesting to know the financial aspects or statistics of this subject, the cost of keeping a city clean and the cost of time lost on account of ill-health and the cost of so-called remedies used in attempting to counteract the evil influence of the dust. There is of course a wide gap between a headache or a cold and pneumonia or tuberculosis, there are all stages of ill-health between such extremes and between the attendant loss of time and money.

Some of the nostrums are advertised for the cure of specific diseases like tuberculosis or consumption—a disease easily curable as a rule, in its early stages, but not by swallowing a lot of patent medicines. What is not claimed for patent medicines is not worth claiming. That reputable physicians do not prescribe patent medicines needs scarcely be mentioned.

It is of some interest to know that some of the most widely advertised nostrums can be made at a cost of one or two cents per gallon—the container and label of many costing more than the ingredients. There must of necessity be a large margin of profit or a "medicine" costing a few cents and selling for a dollar could not be advertised so extensively and so persistently.

In conclusion: As our country becomes more and more densely populated various sanitary problems arise and press for solution. This is especially true of our cities. Houses of brick and stone are displacing those built of wood and thus lessening the danger from fire. The open ditch has given place to the undergrouad sewer; the mud road to the paved street. Shallow wells disappear before the advent of water works, and the latter themselves are getting a better supply by means of filtration.

Water-borne diseases have been reduced to a minimum in many cities and epidemics are prevented. The occurrence of many diseases, such as the plague, cholera, typhus, smallpox and the like, have been reduced to a minimum, if not entirely prevented, by proper precautions, based on a proper knowledge of their active cause and its diffusion.

What about preventing the ravages of ailments and diseases transmitted through the agency of the dust? What are we doing to reduce the amount of dust to a minimum? What efforts are we making to have pure air in our public halls, churches, street cars, and in the city generally?

What shall we do with the persistent floor and sidewalk spitter? Will education cause him to be displaced by a generation of non-spitters? What can we do for the poor, ignorant man, and his family, who keeps himself poor buying patent medicines—medicines which may give relief but which can not cure.

The chief charts used in illustrating the paper were as follows:

1. Chart showing the common names used in patent medicine advertisements. The names were arranged in three columns, the first giving names of ailments of a catarrhal nature or of the respiratory system, and marked in red; the second column, marked in blue, contained names of the rheumatic and aching type, thus::

"Catarrh"	"Rheumatism"
"Colds"	"Backache"
"Grip"	"Lame Back"
"Sore Throat"	"Kidney Disease"
"Pleurisy"	"Aching Joints"
Etc.	Etc.

In the third column were given the names used more especially in connection with the nervous and gastric manifestations of dust infection, such as nervousness, headache, neuralgia, gastritis, a touch of malaria, etc.

2. Chart showing the amount of space occupied by advertisements of patent medicines in the newspapers of different cities and towns. The total space occupied by medical ads of all kinds, and that means of nostrums and of quacks, varied from 2.5 to 14.2 per cent., while the ads of dust disease nostrums (as indicated on chart 1) varied from 1.1 per cent. in a comparatively clean city, up to 10 per cent. (and even more) in a dusty city.

(Are we justified in concluding that if the inhabitants of a clean city pay $1.10 per year, those of a dusty city are compelled at the same time to pay $10.00 for patent medicines?)

3. An exhibit of the total number of ads and the amount of space they occupy in newspapers of half a dozen different cities. Clippings all pasted on long rolls of paper. The contrast between a clean and a dusty city is thus shown in a striking manner.

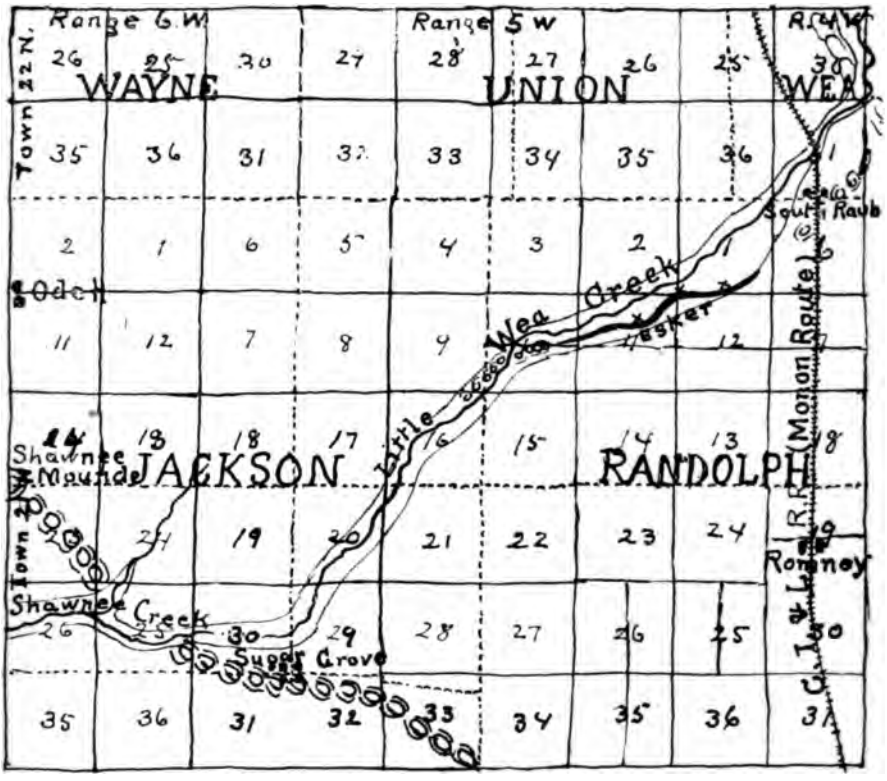
4. A selection of large ads, some occupying a full page. Most of these appeared at times when the dust was at its maximum, namely in the fall and again in the spring. The title of this sheet was: "Who Pays the Bill?"

5. Chart showing the seasonal prevalence of patent medicine ads. The fall and spring tides; low ebb in the summer. (In the summer the sputum on the sidewalks is sterilized by the hot rays of the sun, the streets are sprinkled and doors and windows are open.)

6. Clippings pasted on sheets showing the changes in names in the same advertisement at different times of the year, and from day to day or week to week. The words catarrh, colds, rheumatism, kidney disease, etc., being marked in red or blue—as indicated on chart No. 1.

An Esker in Tippecanoe County, Ind.

Wm. A. McBeth.



An Esker in Tippecanoe County, Indiana.

An esker or serpent kame is a serpentine ridge of sand and gravel evidently formed by a stream flowing in a tunnel at the bottom of a glacier or in a canyon through it.

An interesting example of this feature extends through sections 1, 2, 11, and 10, Town 21 north, Range 5 west, in Tippecanoe County, Indiana. Its northeast end is about one-half mile southwest of South Raub, a station on the C. I. & L. Ry. (Monon Route) nine miles south of Lafayette.

From the station and railway, it is visible and easily distinguished from the bordering prairie lands by its forested surface.

This ridge exceeds two miles in length and varies in height from a few feet at the ends to fifty or sixty feet along the main body. Its sides slope at angles of 20° to 35° away from the arching crest. Its height is quite uniform, but few irregularities occurring in the whole length. The base of the ridge is from twenty to thirty rods wide.

An interesting observation is that the outside or convex sides of bends have the steeper slopes, a fact bearing on the theory of stream origin.

The material is stream gravel assorted from the glacial drift arranged in layers which slope to the southwest. This arrangement of the material indicates stream action and shows the course of the stream that deposited the esker. Excavations to obtain gravel for road making occur at points x x x shown on the map and the characteristic structure is shown in each. Mounds of gravel occur in line with the general trend of the esker at each end. A chain of these elevations extends a mile from the southwest end.

The valley, a half mile wide, comprising the esker trough, extends from the vicinity of South Raub station to the Independence-Darlington moraine near Sugar Grove, where it crosses the divide and connects with the valley of Shawnee Creek, which flows west. The trough is now traversed by the Little Wea Creek, which flows northeast, just the reverse of direction followed by the stream which built the esker. This creek rises at the gap through the moraine at Sugar Grove and it leaves the trough by a deep narrow valley through another moraine at a little distance north of South Raub. Mounds of gravel near the station and further to the northeast may lie in the course of the stream that deposited the esker.

The problem of the slope of the esker trough opposite to the direction of the sub-glacial stream that originally corraded it suggests the explanation of hydrostatic pressure in the tunnel.

The cause of the deposit of gravel and sand as an esker may be related to the reverse slope of the esker trough causing the stream to grade up to a slope line in the opposite direction, which would carry it over the divide at Sugar Grove.

Notes on the Delta of the Mississippi River.

William A. McBeth.

The large scale map of the Alluvial Valley of the Lower Mississippi River published by the Mississippi River Commission, St. Louis, Mo., is a fine example of map making and a most valuable adjunct to geography study in the public high schools and colleges.

A study of this map reveals many interesting facts related to the growth of the delta that the stream has formed in the edge of the Gulf of Mexico. Various questions are suggested by this study. What land area has been added to the continent by the river? What facts or features observable on the map indicate delta area? What is the origin of such lakes as Pontchartrain, Maurepas and Grand? How do the lakes in the delta differ from those along the river above Baton Rouge? What do the bays along the seaward border of the delta indicate as to the manner of growth of the land area and of the origin of lakes in the delta? Why does the river become straighter toward the mouth? What is the cause of the abrupt bend just below New Orleans? Why does the river flow so persistently to the southeast through the delta?

It is generally stated that the delta extends from the mouth of Red River southward because here the distributary farthest upstream leaves the river. This statement seems somewhat arbitrarily derived from the earlier definition which describes a delta as the land included within the divided mouths of a river, rather than the land formed by a river about its mouth. A line extended from Baton Rouge to New Iberia connects the south edges of the uplands on the opposite sides of the river and seems a proper division between the filled valley above and the area of added land or delta proper. South of this line, the great fan of the delta projects, breaking the great curve of the north shore of the gulf. Below this line the shape and size of the lakes change abruptly from narrow, ox-bow lakes, formed by the river cutting across the necks of its bends, to large, broad, irregular shaped lakes, evidently formed by irregular deposit, leaving areas of the gulf unfilled. Lake Pontchartrain, for example, is a portion of the former gulf surface inclosed between the uplands to the north of it and the advancing delta on the south. Notice how near the south shore of this lake the river flows. Notice the stream from within the limits of New Orleans extending along the strip of land

The Delta of the Mississippi River.

between Lake Pontchartrain and Lake Borgne. This stream is evidently a former distributary of the main stream. The bays along the edge of the delta of which Barataria, Timbalier and Terre Bonne are examples, show how the advancing delta arms extend around areas of gulf and hem them in. Notice particularly Bay Marchand, at the mouth of Bayou la Fourche, and the separation of Timbalier and Terre Bonne bays by the long narrow delta of Bayou Terre Bonne.

This inclosing process is aided by the formation of barrier beaches from point to point by wave action. True delta area is further indicated by the straighter course of the river below Baton Rouge. The river is very meandering through the whole length of the alluvial valley on account of the gentle slope of the river bed, but below Baton Rouge it becomes increasingly straight, although in the distance of two hundred forty miles the fall is but five feet, or one-fourth inch per mile. As streams always acquire the meandering habit on gentle slopes, this apparent contradiction of the law of stream flow furnishes an interesting problem. I propose this explanation: The river flowing into the gulf produces a current some distance out from the shore along the sides of which the sediment is deposited more rapidly than in the swifter central line of flow. Finally the narrow mud banks appear above the surface along the course laid out by the current in the still waters of the gulf. The tendency to meander shown at the head of the delta indicates the inclination of the stream to conform to law. The stream is forming meanders. Below New Orleans an abrupt bend appears as an apparent refutation of the explanation of the straight lower course. This bend represents an accident in the direct forward movement of the delta. Observe the streams beginning near the eastern curve of this bend and the tract of land extending east and partially inclosing Lake Borgne and Mississippi Sound on the south. These streams and this strip of land indicate a former course of the river. A crevass across the narrow south bank caused the abandonment of the part below and the abrupt turn of the river. A crevass called "The Jump," twenty miles above the mouth of the river, indicates how a repetition of the above accident may occur. A submarine fan is approaching the surface outside of this gap. The southeast trend of the river through the delta and of the main area of the delta itself may be due to the eastward movement of the Gulf Stream off shore which deflected the incoming river current to the east.

The Poisonous Plants of Indiana.

Stanley Coulter.

It is the purpose in this paper to consider only those plants occurring within the limits of Indiana, which are said to be *contact poisons*. The list as assembled from various authorities is sufficiently extended to raise question as to the character of the facts upon which the forms were included among the contact poisons. The list, as I have been able to collate it, is as follows:

Alisma Plantago-aquatica L. Water plantain.

Arisaema triphyllum (L.) Torr. Jack in the Pulpit. Indian Turnip.

Arisaema Dracontium (L.) Schott. Green Dragon.

Spathyema fœtida (L.) Raf. Skunk Cabbage.

Veratrum viride Ait. Indian Poke. White Hellebore.

Cypripedium hirsutum Mill. Yellow Lady's Slipper.

Urtica gracilis Ait. Slender Nettle.

Urtica dioica L. Stinging Nettle.

Urticastrum divaricatum (L.) Kuntze. Wood Nettle.

Polygonum hydropiper L. Smartweed. Water Pepper.

Polygonum punctatum Ell. Water Smartweed.

Phytolacca decandra L. Pokeberry.

Actæa rubra (Ait.) Willd. Red Baneberry.

Delphinium consolida L. Field Larkspur.

Anemone quinquefolia L. Wind flower. Wild Anemone.

Clematis Virginiana L. Virgin's Bower. Wild Clematis.

Ranunculus sceleratus L. Ditch Crowfoot. Cursed Crowfoot.

Ranunculus acris L. Tall or Meadow Buttercup.

Ranunculus bulbosus L. Bulbous Buttercup.

Podophyllum peltatum L. May Apple. Mandrake.

Sanguinaria Canadensis L. Bloodroot.

Cruciferae: Various genera, including the mustards, pepper-grass and horseradish.

Drosera rotundifolia L. Round-leaved Sundew.

Ailanthus glandulosa Desf. Tree of Heaven.

Euphorbia: Not only all of the fourteen species reported from Indiana, but all of the hundred of more species occurring in the United States.

Rhus Vernix L. Poison Elder. Poison Ash. Poison Dogwood.

Rhus radicans L. Poison Ivy. Poison Oak.

Dirca palustris L. Leatherwood. Moose-wood.

Aralia spinosa L. Angelica Tree. Hercules Club.

Solanum Dulcamara L. Poison Nightshade.

Datura Stramonium L. Jamestown or Jimson-weed. Thorn Apple.

Datura Tatula L. Purple-stemmed Jimson.

Verbascum Thapsus L. Common Mullein.

Catalpa Catalpa (L.) Karst. Catalpa. Indian Bean.

Lobelia inflata L. Indian Tobacco.

Xanthium strumarium L. Cocklebur. Burthistle.

Solidago: All species to be regarded with suspicion by persons with sensitive skins. Solidago odora Ait., said to be particularly dangerous because of a "volatile oil that is an irritant and rubefacient."

Leptilon Canadense (L.) Britton. Horse-weed. Flea Bane.

Bidens frondosa L. Common Beggarticks. Spanish Needles.

Anthemis Cotula L. Common Dog-fennel.

Arctium Lappa L. Burdock.

To these may be added the commonly cultivated—

Tropæolum majus L. Nasturtium.

Nerium Oleander L. Oleander.

Primula obconica Hance. Primrose.

This is a rather startling array of dangerous plants, especially to the field botanist who has been handling most of them with perfect impunity for years. It occurred to me some years ago that it would be interesting to examine the list carefully and so far as possible to conduct a series of experiments confirming or disproving the correctness of the inclusion of the above forms in the list. This I have been able to do with the aid of a number of students who offered themselves as subjects for the experiments. In the last five years I have been able to secure twenty-two persons to aid me in the work.

The most cursory examination breaks the preceding list into two sharply separate groups. In the one the skin irritation is due to the action of some specific substance of the plant, as in the case of Rhus; in the

other the skin irritation is plainly due to mechanical causes, as in the case of Arctium and Xanthium. There seems to be no good reason why any plant with piercing surface outgrowths, such as Bur-grass (Cenchrus tribuloides L.), should not be included in the latter group and the list almost indefinitely extended. Very little was done experimentally with such plants, for though persistent and sometimes festering sores may result from handling them, the irritation is due to traumatic, not to toxic, causes.

In the first group of plants an additional separation may be made into those poisonous by mere handling and those whose poisonous properties seem to be liberated only as the result of dry trituration or grinding, the well known irritant effects of the dust arising from the dried roots of Podophyllum being a case in point.

It will thus be found that the number of plants which are really contact poisons, under ordinary handling is very much reduced and the long continued immunity of those of us who have collected widely is not after all as wonderful as it might at first seem. As a matter of fact it would seem that any plant, which in any way and under any conditions however extraordinary produced a skin irritation had been promptly placed among the contact poisons. There is also to be considered the personal idiosyncrasy. Some persons are peculiarly susceptible to plant poisons, either because of an especially sensitive skin or of some constitutional condition which makes them remarkably non-resistant to the sequelae of skin lesions of any sort. As a result of this consideration of the personal equation the list of plants poisonous by contact is still further reduced.

A rather careful experimental study of the plants in the above list has been made with the following results:

In all cases the procedure was simple but was deemed sufficient to demonstrate the poisonous or non-poisonous character of the plant. The plant was first handled freely in the way of collecting and making herbarium specimens. If after some days no results were apparent, the part of the plant said to contain the poisonous element was rubbed upon the back of the forearm until serum, and at times blood, exuded, the juice of the plant and the serum being allowed to dry upon the arm. If no results followed, it was considered safe to infer that the form was not a contact poison.

Water plantain (Alisma Plantago-aquatica L), common throughout the state in mud and shallow waters, is said by the National Dispensatory to

contain in the leaves "an acrid principle strong enough to irritate the skin." No one of the twenty-two subjects showed the slightest trace of skin irritation as the result of treatment as indicated in the preceding paragraph. The leaves were taken at different dates, but no results confirming the above statement were secured.

The Indian Turnip and Green Dragon (Arisæma triphyllum (L.) Torr., and A. Dracontium (L.) Schott) are said to be "violently acrid and almost caustic in every part, frequently producing intolerable itching and inflammation of the skin." None of the twenty-two subjects showed the slightest unpleasant results from the free handling of the above species. As a result of the more vigorous treatment five showed a vesicular inflammation lasting for three or four days. The inflammation was accompanied by considerable itching, which, however, was not so violent as to merit the term "intolerable." Of the five showing unpleasant effects, two were young ladies, who proved so susceptible to almost any type of skin lesions that they were unable to continue the work.

The Skunk Cabbage (Spathyema fœtida (L.) Raf.) is said to be "harmless as to the leaves, but with root so acrid as to produce intolerable itching and inflammation." No results were secured from frequent and rather rough handling of the roots. Later the juice was expressed by pressure and allowed to dry upon the arms, rubbed to extreme redness, of five subjects. Neither itching nor inflammation resulted. The latter test was repeated in April, May, June and September, four additional subjects being used, but in every case failing to confirm the reputation of the plant as a skin irritant.

Indian Poke (Veratrum viride Ait.), sparingly found in many localities, growing in swamps and wet woods, will, it is alleged, if "applied to the skin in moist condition cause redness and burning." The plant is so occasional in its occurrence that it need scarcely be taken into account. Two experiments upon myself gave absolutely no redness or burning. It is, however, fair to state that these experiments should not be regarded as determinative, since not even the poison ivy (Rhus radicans L.) produces any skin irritation, except when the skin has been rubbed to redness with the crushed leaves and the juice allowed to dry upon the surface.

Cypripedium hirsutum Mill., the Yellow Lady's Slipper or Moccasin flower, is said to be "irritating to the skin, in some cases poisoning as severely as Rhus." Eleven out of the twenty-two persons experimented

upon showed unpleasant effects from the mere handling of this species in collection and determination. Six others were poisoned as a result of the rubbing process, only five escaping entirely. In almost every class I have numerous cases of poisoning easily referable to this form. The poisonous property seems most active during the flowering season, the plant being practically innocuous after seed maturation. The effect shows first as a hyperæmia, later becoming vesicular and even pustular if untreated. It yields readily, however, to ordinary emollient treatment and can be fairly limited in its spread by frequently bathing the adjacent parts with alcohol. My attention was first called to the poisonous character of the plant by Dr. D. T. MacDougal and continued observation but serves to confirm the view that many cases of poisoning attributed to the poison ivy should be referred to this species. The attractiveness of the flower serves to lead many persons to collect it in large masses and if the results reported above are at all indicative, it is doubtless chargeable with many cases of poisoning occurring in the early spring.

The nettles including Urtica dioica L., Urtica gracilis Ait. and Urticastrum divaricatum (L.) Kuntze, poison through the action of acrid constituents, producing an intolerable burning. The inflammation, however, yields so readily to treatment by cooling lotions and is so ephemeral in its character if untreated, that the plants are to be considered as annoying rather than poisonous. None of twenty-two subjects escaped the intense burning following the handling of these forms. The inflamed condition never persisted over two or three hours even after a rather vigorous whipping of the skin with the plants.

Of the Smartweeds, two, Polygonum hydropiper L., and P. punctatum Ell., it is said "cause itching and burning of the skin." In the experiments tried this proved true if the expressed juice was applied to mucous membranes, especially those of the eye. In no case was any irritation observable where the application was to the skin. In this case also, the irritation was but temporary and yielded readily to bathing the affected parts in cold water.

That Pokeberry (Phytolacca decandra L.) contains a principle which is an internal poison is well known. The claim, however, that the "green plant and root irritate the skin, affecting chiefly mucous membranes," does not seem to be so well made out. Only eight subjects were treated with this species and in no instance were any inflammatory symptoms ob-

servable. Later the dried root was ground and a very annoying and somewhat persistent irritation of the mucous membranes of the eye resulted, yielding only to treatment by an oculist. It is fair inference that no part of the Pokeberry is a contact poison in the ordinary acceptance of the term, although the plant does possess a poisonous principle which under exceptional conditions may produce an inflammation of a somewhat obstinate and therefore serious character.

The Baneberry (Actæa rubra (Ait.) Willd.) is said to contain a "vesicating principle." Experimentation upon fifteen subjects failed to verify this statement. In this case, as in all others where negative results were obtained, the experiments were repeated several times at different stages of the development of the plant.

The Field Larkspur (Delphinium consolida L.) is also claimed to be a skin irritant. "A specific element in the seeds produces in tincture great burning and inflammation of the skin." The experiments upon this form were unsatisfactory because of the small amount of material available. The tincture applied to the skin produced some slight burning and inflammation, although the latter was no greater than would be expected from a similar treatment with pure alcohol. Evidently, however, the Field Larkspur is in no sense to be considered a plant dangerous to handle.

The Wild Anemone or Wind flower (Anemone quinquefolia L.), said to be "irritating to the skin, producing redness and itching," was found, so far as the experiments went, to be perfectly innocuous, not even those who were most susceptible to skin irritations showing the slightest sign of inflammatory symptoms.

The Virgin's Bower or Wild Clematis (Clematis Virginiana L.), said to contain an "acrid irritant producing blisters", affected nine out of seventeen subjects; four by the mere handling, the other five as a result of rubbing the skin with the leaves and flowers. A marked hyperæmia preceded the vesicular stage of the inflammation, which in no case was of more than three days duration.

Three of the Crowfoots or Buttercups (Ranunculus sceleratus L., R. acris L., and R. bulbosus L.), it is alleged, 'cause inflammation and ulcers, the root being especially rich in poisonous substances." Of these R. sceleratus and R. bulbosus are sufficiently occasional in our area to be neglected. R. acris, also, as at present delimited by systematists, is of relatively scant occurrence in Indiana. Seven subjects were used. None

showed any ill effects from treatment with aerial parts. Two showed sharp inflammation from rubbing the skin with the root, but neither showed any indication of ulcers although the inflammation was left untreated. Inflammatory symptoms disappeared at the end of the sixth day, in both cases.

The familiar May Apple (Podophyllum peltatum L.) has been included in the lists of plants poisonous by contact from the earliest times. Both leaves and roots are said to be "poisonous and drastic" by some authors; others content themselves with the statement "rather poisonous"; still others attribute the "poisonous principle chiefly to the root, the powder of which affects the mucous membranes." Of the truth of the last statement there can be no doubt, as scores of careless or ignorant workers in the laboratories of manufacturing pharmacists can testify. Concerning the other two, there is at least room for reasonable doubt. No record has come to my notice of any case of poisoning from the mere handling, and I have in the past few years directed the work of classes in such a way as to secure the maximum amount of handling of every part of the plant. Twenty subjects submitted to the rubbing process, using aerial parts of the plant, and nineteen showed no signs of inflammation. One was a subject referred to in a previous paragraph as peculiarly susceptible to inflammation after skin lesions of any sort. In this case a rather persistent inflammation followed the experiment, requiring between two and three weeks' treatment before it was completely reduced. Five submitted to the rubbing process with fresh roots with no untoward results. The irritating effect of the dry powder of the root upon mucous membranes was considered too well established to need verification. It is a safe inference that any part of the May Apple may be handled with safety, even the dry root being apparently harmless, and only irritating when in the form of a finely comminuted powder.

The common Bloodroot (Sanguinaria Canadensis L.) is another plant regarded with suspicion by some authors. It is said that the "dust of the dried root is irritating and that frequently the handling of the root poisons." No experiments were made as to the effect of the dust produced by the grinding of dried roots, but both dried and fresh roots were persistently handled without record of poisoning in a single case out of seventeen. Seven showed no ill effects from rubbing the arm with the fresh root.

The Cruciferæ named are such well known irritants as to need no special discussion, although in none of the forms did any irritation arise from a free and rather rough handling of the plants.

The round leaved Sundew (Drosera rotundifolia L.) is classed as a skin irritant. It is so rare in our area that it scarcely deserves mention. Experiments were possible only with dried specimens. Of the five subjects selected none showed any signs of skin irritation as a result of either treatment. The material used was collected in August, the experiments were made the following February, the plants having been subjected to the usual drying.

The Tree of Heaven (Ailanthus glandulosa Desf.), it is said, "should be regarded with suspicion." No experiments were tried with this form and a somewhat extended examination fails to reveal any instance in which poisoning resulted from its handling. Personally I have handled it for years, and have rather encouraged classes to handle it but have failed utterly to find the form at all poisonous or even irritating.

Of the Spurges (Euphorbias) more than one hundred species occur in the United States. Loudon says of them, "Every one is so acrid as to corrode and ulcerate the body wherever applied." This somewhat vigorous arraignment of the genus does not seem fully justified by the behavior of the local forms. In the experiments upon ten subjects E. maculata L., E. humistrata Engelm., E. nutans Lag. and E. commutata Engelm., produced no ill effects from handling. Rubbing the arm vigorously with the crushed plants and allowing the latex to dry produced a marked irritation in five of the ten subjects and a light vesicular inflammation in another. The inflammation was somewhat obstinate, in two cases requiring the attention of a physician. In the case of the flowering Spurge (Euphorbia corollata L.) six out of ten subjects were distinctly poisoned by merely handling the plant in its flowering condition. In this case the plant was gathered in masses as for decorative purposes, thus attempting to imitate the manner in which this attractive form is usually handled. Allowing the latex to dy upon the arm caused evident poisoning in nine of the ten cases. The experience with the other species named above led to the prompt treatment of the inflammations, so that nothing can be said as to the persistence or ultimate character of the irritation. The inference may be drawn that the majority of our native spurges are not such virulent contact poisons that they can not be handled in the ordinary way without danger. Euphorbia corollata is, however, to be regarded as dangerous,

especially in the flowering period, and, as that extends from April to October, it is probably to be avoided at all times. Apart from the results of these experiments I have records of twenty-three cases of poisoning unmistakably chargeable to this form. In my opinion many cases of poisoning attributed to Rhus are to be referred to this species.

Of the Sumach, the poison ivy (Rhus radicans L.) is perhaps the most familiar, although the poison elder (Rhus Vernix L.) is by far the more poisonous. According to Robert Hessler, M. D.,[1] "Many persons proof against the common poison ivy readily succumb to this species." Fortunately the restricted range of the species, it being confined to the swamp regions of the northern part of the state, its favorite location being tamarack swamps, prevents it from being as dangerous as its virulence would indicate. The poison ivy, however, because of its almost universal distribution through the state is perhaps the most dangerous of the plants in the list. In the experiments, seventeen out of twenty-two poisoned by merely handling the plant. The remaining five responded vigoriously to the rubbing process. The character of the inflammation is too well known to need description in this connection. One of the subjects, a young man of about twenty-two, who was poisoned as the result of "rubbing," allowed himself to go without treatment for three weeks, in order that he might determine whether or not he would in the future be more susceptible to ivy-poisoning. His case of poisoning was quite severe, involving the whole arm and spreading to the neck, being perhaps more serious than ordinary cases. He wrote me last summer that he had not since the experiment escaped with less than two or three poison attacks a year. I have heard from two others that they also have poisoned since that time by the slightest contact with poison ivy. On the other hand, the other two members of the group of five do not seem to poison any more readily than before the experiment. In the poison ivy, also, the poisonous principle seems most active during the flowering season. The statement that Rhus poisoning occurs from the handling of dried herbarium specimens has not proven true in my experience. Determinative material placed in the hands of class after class, has never caused a single case of poisoning. It is fair to conclude that two out of three persons will be more or less affected by simply handling poison ivy, and perhaps nine out of ten if the plant is handled at all roughly. No other one of our indigenous plants is so generally poisonous.

[1] Proc. Ind. Acad. Sci., 1896, p. 21.

It is said of the Leatherwood (Dirca palustris L.) that the "fresh bark applied to the skin causes redness and vesication and sores, which are very difficult to heal." Eight subjects were treated by binding pieces of freshly stripped bark upon their arms, allowing them to remain for periods ranging from two to twenty-four hours. Six showed no evil effects of any kind, while in the cases of the other two a somewhat painful hyperæmia resulted, easily reduced by an application of vaseline. Somewhat strangely, the two affected represented the extremes of time, two and twenty-four hours. Three other students chewed the fresh bark for a few minutes and in each case an extremely painful blistering of the mouth resulted. In my own case, tried subsequently, the mucous membranes of the mouth did not become normal for nearly a month. In the ordinary use of the term, the leatherwood is not a contact poison, although in exceptional cases it may prove such.

Aralia spinosa L., Angelica Tree or Hercules Club, was found without irritating principle in three cases, the small amount of material available precluding more extended experimentation. It is claimed that "green bark from roots or small shrubs acts as an irritant." As far as the results go the statement is without foundation.

It is the popular belief that Solanum Dulcamara L., poison or purple-leaved nightshade is one of the most virulent contact poisons. By some authorities it is claimed to be an even more virulent skin poison than poison ivy, the symptoms being similar, but the poison much more difficult to eradicate from the system. Tests made upon fifteen subjects failed utterly to justify the popular view. The plants were used in all stages and at all seasons, but in every case without the slightest irritation. I have tried many times to poison myself with this species, frequently taking plants selected by persons who claimed an absolute knowledge of the poisonous character of the form and always without untoward results. The result of these experiments makes it almost certain that the purple-leaved nightshade should not be considered as one of our poisonous plants.

The "Jimson" weeds (Datura Stramonium L. and D. Tatula L.) also have a bad reputation. Fourteen subjects were tested and in no case was there any sign of inflammation. No experiment was made to verify the statement that the forms "occasionally cause a swelling of the eyelids." It is probable that none of our native species of Solanaceae are as poisonous as the foliage of the potato and tomato, to which frequent cases of skin poisoning may be definitely referred.

The common Mullein (Verbascum Thapsus L.) is irritating to the skin because of its wooly hairs, the leaves being often applied to the throat for the rubefacient effect. Its action is so evidently mechanical that no experiments were tried.

The flowers of the Catalpa (Catalpa Catalpa (L.) Karst.) are said to be irritant to many persons, causing "reddening of the skin." In experiments tried and often repeated upon twenty subjects, no such results were obtained, although in some cases the flowers were rubbed upon the cheeks vigorously, the juice being allowed to remain for several hours. I have also been unable to find any definite record confirming the statement.

Indian Tobacco (Lobelia inflata L.), "when applied to the skin is capable of producing irritation." Experiments upon fifteen persons failed to confirm this alleged fact.

The Cocklebur (Xanthium) are irritant on account of dust and hairs with which they are covered and not because of a toxic principle. No experiments were made with this form.

Of the Goldenrods (Solidago) the statement is made that the "whole family is to be regarded with suspicion by persons with sensitive skin. Solidago odora Ait. possesses a volatile oil that is an irritant and rubefacient." Twenty-two persons were subjected to tests with various species of goldenrod, but no results were obtained to indicate the presence of a toxic element in our native species. Solidago odora was used with five subjects without resulting inflammation. It is extremely doubtful whether any skin irritation is produced by species of this genus save through mechanical causes.

The common Fleabane (Leptilon Canadense (L.) Brit.) it is said "contains a volatile oil possessing irritating qualities to those handling." Eleven persons were used in experiments upon this form. Two had skin irritations following the free handling of this plant. Five others were poisoned by the "rubbing" process. Four were unaffected under either procedure. In this case also, the maximum point of the toxic principle seemed to be the flowering season.

Common Beggar Ticks or Spanish Needles (Bidens frondosa L.), it is alleged, "causes itching on handling." Out of fifteen persons this was found to be true in three cases, one of them being peculiarly susceptible to skin irritation, as mentioned in a preceding paragraph. Four others were affected by the "rubbing" process. The remaining eight reported no change in skin sensations.

Ordinary Dog-fennel (Anthemis Cotula L.) was found to affect seven out of twenty persons as the result of free handling. Seven others were poisoned following rubbing and six were unaffected. The statement that the "juice is sufficiently acrid to poison sensitive skins" seems borne out by the results.

Arctium Lappa L., or Burdock, is a skin irritant through mechanical action, the dry burs producing the most serious inflammations, although the leaves, because of their roughness, are also irritant. The resultant inflammations after handling were so evidently traumatic that no experiments were made.

It is claimed that the ordinary cultivated Nasturtium (Tropæolum majus L.) "in exceptional cases produces dermatitis." Repeated experiments with all parts of the plant upon twenty-two subjects failed to give any verification to this statement. After extended inquiry I have failed to find any person who knew of any case of poisoning due to this plant.

The Oleander (Nerium Oleander L.), so largely cultivated, is probably under certain conditions poisonous. "An acrid principle in the leaves affects some people as Rhus." Loudon contents himself with saying "it is poisonous." Figuier calls it a "formidable poison." Van Hasselt says it causes "an internal burning and itching when rubbed in the skin." Five persons were experimented upon in the manner indicated by Van Hasselt and all suffered a greater or less irritation accompanied by burning and itching. It is probable that the thick-walled epidermal cells prevent poisoning in the ordinary handling of the plant. The most painful case of skin poison I experienced was from the oleander. It was, however, of short duration and in none of the cases indicated the persistence or tendency to recurrence of Rhus.

Of the cultivated Primroses, one, Primula obconica Hance, is occasional irritant. The cause, however, is plainly enough traumatic. No experiments were undertaken, although I know of one case in which the handling of this species is invariably followed by an annoying skin irritation.

The results of these experiments may be summarized as follows:

1. The great majority of the plants included in the preceding list are harmless under ordinary handling.

2. Some of these may act as skin irritants as the result of prolonged application or unusually rough handling. Careful washing after handling any of the forms will reduce the danger to a minimum.

3. The following species are definitely contact poisons, arranged in order of their virulence.

Rhus Vernix L.

Rhus radicans.

Euphorbia corollata.

Cypripedium hirsutum.

Anthemis Cotula.

Leptilon Canadense.

Clematis Virginiana.

Bidens frondosa.

The nettles are not included in this list on account of the ephemeral character of the irritation they produce, nor are there included a number of forms which poison under unusual conditions, such as grinding or long continued applications.

4. Of the plants named, the two species of the genus Rhus are the only ones affecting all upon whom experiments were tried, if we except the nettles.

5. Sixteen plants included in the list proved absolutely harmless under the conditions of the experiments. Probably all in the list with the exception of the first three or four may be safely handled under ordinary conditions.

The data bearing upon conclusion 3 may be tabulated as follows:

	Number of Subjects in Experiment.	Affected by First Method.	Affected by Second Method, Additional.
Rhus Vernix	No	Experiments.	
Rhus radicans	22	17	5
Euphorbia corollata	10	6	3
Cypripedium hirsutum	22	11	6
Anthemis Cotula	20	7	7
Leptilon Canadense	11	2	5
Clematis Virginiana	17	4	5
Bidens frondosa	15	3	4

Amphispores of the Grass and Sedge Rusts.

J. C. Arthur.

(Abstract.)

The paper described and illustrated the uredospores and amphispores of five species of *Puccinia* from central United States, and one species of *Uromyces* from Northern India, all occurring upon various kinds of grasses; they were *P. vexans* Farl., *P. Tripsaci* D. & H., *P. Stipæ* Arth., *P. tosta* Arth., *P. Cryptandri* E. & B., and *U. Rottboelliæ* Arth. It also described and illustrated the amphispores, the uredospores not being known, of three species of *Puccinia* from the United States occurring upon different species of *Carex;* they were *P. Caricis-strictæ* Diet., *P. atrofusca* (D. & T.) Holw., and *P. Garrettii* Arth. These are all the species of rusts so far known to possess amphispores. This kind of spore is the resting or winter form of the uredospore. They are not uredospores, however, accurately speaking, because they show distinct structural differences, often very great, and are correspondingly modified physiologically.

Ecological Notes on the Birds Occurring Within A Radius of Five Miles of the Indiana University Campus.*

By Waldo Lee McAtee.

With Photographic Illustrations by Clarence Guy Littell.

At various times since 1883 students of Indiana University interested in birds have kept records of the migrations, breeding habits, etc., of the birds within a radius of several miles of Bloomington. Twenty sets of migration records, covering fourteen seasons, are on file in the archives of the Biological Survey at Washington, D. C.

Three lists of birds have been prepared by former students.

W. S. Blatchley in 1886 recorded the "Winter Birds of the Vicinity of Bloomington, Indiana," in the Hoosier Naturalist I, pp. 169-171.

B. W. Evermann published a list of "Birds of Monroe County, Indiana," in the Hoosier Naturalist II, pp. 137-145 and 164. He enumerates 179 species.

C. H. Bollman listed 192 species in an unpublished paper on file in the Biological Survey.

"The Hoosier Naturalist," in which Evermann's and Blatchley's lists were published has long been extinct and the two papers are not accessible.

Some of the above lists and part of the migration records were used by Amos W. Butler in his "Birds of Indiana" published in the 22d Annual Report of the Department of Geology and Natural Resources, Indianapolis, 1897.

Pertinent facts contained in the above sources have been brought together in the present paper. They have been confirmed or supplemented by the author's observations extending through the last four years. While the material presented is chiefly of local interest it contains additions to our knowledge of the birds of Indiana and the more general subject of bird migration. Wherever possible, the authority for any state-

*Contributions from the Zoölogical Laboratory of Indiana University, under the direction of C. H. Eigenmann. No. 60.

ment is indicated. When no authority is given the author is responsible for the data.

The following is a list of observers most quoted. Their initials are used to indicate their authority.

V. H. Barnett.
W. S. Blatchley.
C. H. Bollman.
C. H. Eigenmann.
B. W. Evermann.
W. L. Hahn.
P. J. Hartman.
C. H. Kennedy.
E. M. Kindle.
C. G. Littell.
W. L. McAtee.
N. B. Myers.
A. B. Ulrey.
G. G. Williamson.

When other authorities are quoted their names are given in full.

To make the facts contained in this paper more readily accessible to teachers and students they have been placed in tabular form and appear at the end of the paper. The table and the index were prepared by C. H. Frazee and Leonard Haseman.

The region over which observations have been made, embracing the territory within about five miles of Bloomington, is varied in its topography. On the east and north are many rocky ravines, some of them containing cascades. At Bloomington, to the south of it and some distance to the west the surface is gently rolling and has typical features of the oölitic limestone area of Indiana. To the west in the Mitchell limestone area the surface is pitted with various sinkholes beneath which are caves of considerable extent. Bloomington and the area about it are well drained by rock bound brooks running in part to the north through Rocky Branch, Griffy Creek and Bean Blossom, finally flowing into the North Fork of White River. Other brooks, the Jordan River and Clear Creek drain the southern part of Bloomington through Clear Creek into the East Fork of White River. The extreme eastern part of the area is drained into Salt Creek and thence into the East Fork of White River. The western part

is rich in springs and sinkholes filled with water, the general trend of the underground drainage of this area being southward. There are no large streams or other large bodies of water or swamp in the region under consideration. Two artificial ponds have been constructed in recent years, a smaller one which supplies the Monon R. R. yards with water and a larger one which is the storage reservoir of the Bloomington waterworks.

The region is fairly forested, largely by second growth timber, though in some parts of the Knobstone region the primeval forests remain.

The area is not well suited to aquatic birds but offers many favorable localities to terrestial migrants and residents.

The total number of species recorded is two hundred and twenty-five, and includes seventy per cent. of the birds recorded from the entire State. Of this number ninety-eight nest here and thirty-nine of the breeding birds are also permanent residents. Twenty-one are winter visitants. Ninety-six are migrants and are seen during a few days in spring and fall. Six are extinct, two are included on rather doubtful evidence, and one is a hypothetic species. The last three groups are included in the supplemental list. One hundred species have been observed on or over the University Campus.

Each species which has been observed on or over the campus of Indiana University is marked by an asterisk. In cases of species which are either winter or summer residents, the recorded extremes of their stay are given. In the case of transients the limits of their arrival and departure are given for both of the migratory seasons. Extinct and hypothetic species are referred to a supplemental list. The numbers in brackets and the nomeclature are those of the A. O. U. check-list.

I am under obligations to Prof. W. W. Cooke and Mr. A. W. Butler for permission to examine migration schedules.

1. [3] *Colymbus auritus* Linn. Horned Grebe.

Common migrant. April 11 to 24. This species is classed as a common migrant wholly upon evidence obtained in the spring of 1903. It had not heretofore been recorded from the county, but circumstances lead me to believe that it has merely been overlooked. The first specimen was obtained April 11, by Mr. J. J. Batchelor and Mr. James Simonton. Three others were seen that day. The following numbers were seen at the dates given:—7, April 12; 4, April 13; 2, April 17; 2, April 18; 2, April 19, and 2, April 24.

2 [6] *Podilymbus podiceps* (Linn.). Pied-billed Grebe.

Common migrant. March 5 to April 29 and October 7 to November 30. May be found in nearly any sink or quarry-hole during the migratory season.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.
Observer	C. H. B.	C. H. B.	G. G. W.	G. G. W.
First seen	4-3	.....	4-10	3-26
Next seen	4-4	.....	4 16	.....
Common	.....	.....	.....	.....
Last seen	.....	10-7	.....	.....
Abundance	Common.	Not common	.....	Not common

Year	1899.	1899.	1902.	1903.
Observer	N. B. M.	.....	W. L. H.	W. L. M.
First seen	4-19	.....	.....	3-8
Next seen	.....	.....	.....	4-19
Common	.....	.....	.....	4 27
Last seen	.....	11-30	4-29	4-29
Abundance	Rare.	.....	.....	Common.

3. [7] *Gavia imber* (Gunn.). Loon.

Common migrant. April 1 to May 11. Loons may be seen on the larger ponds any morning after a stormy night in April. Before the waterworks and railroad reservoirs were made these birds were not seen. Bollman and Evermann do not give the Loon in their lists of 1886 and 1887.

MIGRATION RECORD.

Year	1886.	1903.
Observer	B. W. E.	W. L. M.
First seen	4-1	4-13
Next seen	.....	4-15
Common	.....	4-15
Last seen	.....	5-11
Abundance	.....	Common.

4. [60] *Larus philadelphia* (Ord). Bonaparte's Gull.

Rare migrant. One record April 16, 1903. A flock of one hundred "gulls" of three sizes was reported in April, 1902, by J. J. Batchelor. From his descriptions I concluded that these were either Forster's or the common Tern, and Bonaparte's and the Herring Gull. When these birds appear so far from any large body of water it is always after a period of very high winds.

5. [69] *Sterna forsteri* Nutt. Forster's Tern.

Rare migrant. Four seen May 13, 1903.

6. [70] *Sterna hirundo* Linn. Common Tern.

Not common migrant (C. H. B. '86).

7. [120] *Phalacrocorax dilophus* (Swain). Double-crested Cormorant.

Rare transient (C. H. B. '86). May 3, 1885 (C. H. B.).

8. [129] *Merganser americanus* (Cass.). American Merganser.

Common migrant. In 1887 B. W. Evermann classed it as not common. In late years, however, the Fish Duck has become a common spring visitor to the reservoirs.

MIGRATION RECORD.

Year	1903.
Observer	W. L. M.
First seen	4-16
Next seen	4-19
Common	5-14
Last Seen	5-14
Abundance	Common.

9. [131] *Lophodytes cucullatus* (Linn.). Hooded Merganser.

Common transient (C. H. B. '86). March 4, 1885 (C. H. B.). Several specimens, without dates, are in the University collection.

10. [132] *Anas boschas* Linn. Mallard.*

Abundant migrant. February 10 to April 23. After the example of Prof. W. W. Cooke all records simply given as "ducks" are referred to this species.

MIGRATION RECORD.

Year	1886.	1892.	1903.
Observer	B. W. E.	E. M. K.	W. L. M.
First seen	3-1	.....	2-10
Next seen	3-4	.....	3-8
Common	.....	4-3	4-23
Last seen	.....	.....	4-23
Abundance	.....	.....	Common.

11. [139] *Nettion carolinensis* (Gmel.). Green-winged Teal.

Not common migrant (B. W. E. '87). March 4 to April 17.

MIGRATION RECORD.

Year	1886.	1903.
Observer	B. W. E.	W. L. M.
First seen	3-4	4-10
Next seen	3-5	.....
Common	.....	.....
Last seen	.....	4-17
Abundance	Not common	Not common

12. [142] *Spatula clypeata* (Linn.). Shoveller.

Common migrant. March 20 to May 8. The first migrants are males and are seen in small numbers; later in the season the flocks are mixed, but the females are then generally in the majority.

MIGRATION RECORD.

Year	1886.	1896.	1902.	1903.
Observer	B. W. E.	W. S. B.	W. L. M.	W. L. M.
First seen	.....	.....	.....	3-20
Next seen	.....	.....	.....	4-5
Common	.....	.....	.....	4-19
Last seen	5-8	5-8	4-13	4-21
Abundance	Not common	.....	.....	Common.

13. 143 *Dafila acuta* (Linn.). Pintail.

Rare migrant. Feb. 26 to March 4.

MIGRATION RECORD.

Year	1886.	1902.
Observer	B W. E.	W. L. M.
First seen	2-26	3-1
Next seen	3-1	

14. [144] *Aix sponsa* (Linn.). Wood Duck.*

Rare migrant. March 24 to May. Formerly a common summer resident (C. H. B. '86), and the most common duck, often seen near the campus (B. W. E. '87). Reported breeding in 1887 (G. G. W.), and in recent years (A. W. Butler, '97). At present this duck is extremely rare; the only one reported since 1897 was seen in May, 1902 (T. J. Headlee).

MIGRATION RECORD.

Year	1885.	1887.
Observer	C. H. B.	G. G. W.
First seen	3-31	3 34
Next seen	4-1	3-26

15. [146] *Aythya americana* (Eyt.). Redhead.

Although this bird is a common migrant in neighboring localities, there is but one record of its occurrence here. Four were taken March 20, 1903.

16. [147] *Aythya vallisneria* (Wils.). Canvas-back.

Common migrant (C. H. B. '86). Common April 23, 1903.

17. [148] *Aythya marila* (Linn.). American Scaup Duck.

One record. March 4, 1886 (B. W. E.).

18. [149] *Aythya affinis* (Eyt.). Lesser Scaup Duck.*

Common migrant. March 9 to May 8. The Little Blue-bill is the most common duck. As is the case with the Shoveller, the first migrants are males. The females, however, are present in larger numbers than the males in the flocks seen later in the season.

MIGRATION RECORD.

Year	1885.	1886.	1902.	1903.
Observer	C. H. B.	B. W. E.	W. L. M.	W. L. M.
First seen	3-30	.....	3-27	3-9
Next seen	..	.....	4-5	1-5
Common	.....	.....	.....	4-21
Last seen	.....	5-8	4-19	4-26
Abundance	.....	.....	Common.	Common.

19. [151] *Clangula clangula americana* (Bonap.). American Golden-eye.

Rather common migrant. There are several records, but the only date at hand is March 1, 1902.

20. [153] *Charitonetta albeola* (Linn.). Buffle-head.

Very rare migrant (B. W. E. '87). March 5, 1886 (B. W. E.).

21. [166] *Oidemia perspicillata* (Linn.). Surf Scoter.

Rare: one seen in 1883, "a storm duck" (C. H. B.). Of very unusual occurrence away from large bodies of water in this latitude. The only other records for the State are for the year 1875.

22. [167] *Erismatura jamaicensis* (Gmel.). Ruddy Duck.

Not common migrant. April 24, 1903.

23. [169.1] *Chen caerulescens* (Linn.). Blue Goose.

Rare migrant (C. H. B. '86).

24. [172] *Branta canadensis* (Linn.). Canada Goose.*

Common migrant. February 17 to April 12. October 31 to November 24. On two occasions, 3-2, '02 and 2-17, '03, Wild Geese were seen flying south. On both of these dates there was a sudden drop in the temperature, in the latter case to six degrees below zero. Those seen 4-12, 1903, were flying through a driving rain. A Canada Goose remained about the campus of the University for about a week ending 3—27, '02. At nights it flew in all directions over the campus from pond to pond, and its loud calling provoked a still more vociferous demonstration from the watchdogs below.

MIGRATION RECORD.

Year	1885.	1885.	1900.	1902.	1902.	1903.
Observer	C. H. B.	C. H. B.	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	3-11		3-3	3-2		2-17
Next seen			3-8			3-2
Common				3-2		
Last seen		11-24			10-31	4-12
Abundance	Common.	Not common		Common.	Common.	Common.

25. [190] *Botaurus lentiginosus* (Montag.). American Bittern.*

Rather rare migrant. April 5 to May 13, August 7 to October 22. Most often seen on the weedy margins of a pond but not rarely in the open glades of a forest, or in the pine groves where they flap heavily from treetop to treetop, making a tremendous clatter in rising and alighting.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1888.	1892
Observer	C. H. B.	C. H. B.	B. W. E.		A. B. U.
First seen		8-27		4-27 ††	4-23
Next seen		9-*			5-†
Common					
Last seen	5-13	10-22	5-5		
Abundance	Rare.	Rare.	Not common		

*Foster Hight. †E. M. K. ††Wylie and Mitchell.

Year	1900.	1901.	1902.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-17	4-25		4-5
Next seen		4-29		4-21
Commmon				
Last seen			5-4	4-22
Abundance				Rath'r rare

26. [191] *Ardetta exilis* (Gmel.). Least Bittern.

Rare migrant. One was taken alive and kept in the laboratory for a week in May, 1902. It was fed small fishes, which it swallowed readily. Its appetite was amazing but was the cause of its death. A large mass of fish bones became stuck in its œsophagus and put an end to his gastronomic feats and to his career.

27. [194] *Ardea herodias* Linn. Great Blue Heron

Rather rare migrant. March 12 to April 30. August 25.

MIGRATION RECORD.

Year	1885.	1886.	1901.	1902.	1903.
Observer	C. H. B.	W. S. B.	W. L. M.	Bicknell.	W. L. M.
First seen	3-25	4-8	4-22	.....	3-12
Next seen	3-26	.....	.....	.....	.....
Common	.....	.....	.....	.....	.....
Last seen	.....	.....	.....	8-25	4-30
Abundance	Not common	.....	.....	.....	Rath'r rare

28. [196] *Herodias egretta* (Gmel.). American Egret.

Rare migrant, not observed since 1887. "The earliest record for Indiana is that given by Prof. Evermann from Bloomington, April 10, 1887" (A. W. Butler). Evermann also says a few were seen in August, 1886. C. H. Bollman called it a rare transient in 1886, but makes the remark that it might be added to the list of summer residents as he had taken it July 29, 1885. It has also been taken in this county by I. N. Corr and S. E. Meek.

29. [201] *Butorides virescens* Linn. Green Heron.* Figs. 1–5.

Common summer resident. April 10 to September 22. In 1901 C. E. Edmonson found a colony of ten or twelve nests in a small clump of cedars near the water-works reservoir. June 3, 1901, a nest was found in a small cedar, about 50 yards from a pond. It was 25 feet high in a dense thicket of small trees. The nest was poorly made of sticks and the eggs were visible from below. There were 5 eggs. On June 11 these were hatched, and on the 19th the young were well covered with down and were hopping around among the branches (W. L. H.). May 11, 1903, a Green Heron's nest with 6 eggs was found 13 feet up in an apple tree in an orchard. Five eggs were in the lower layer, the sixth on top. There was another nest about 20 feet up in an adjoining

tree, which contained four eggs. The eggs in the first nest were hatched May 29 (C. G. L.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1893.
Observer	C. H. B.	C. H. B.	C. H. B.	E. M. K.	E. M. K.
First seen	4-17	.....	4-24	4-22	4-17
Next seen	4-18	.....	4-29	.....	.....
Common	4-28	.....	.....	.....	.....
Last seen	.....	9-22	.....	.....	.....
Abundance	Abundant.	.....	Abundant.	Rare.	Rare.

Year	1899.	1900.	1902.	1903.
Observer	N. B. M.	N. B. M.	C. H. K.	W. L. M.
First seen	5-16	4-17	4-23	4-10
Next seen	.....	5-2	.....	4-14
Common	.....	5-12	.....	5-11
Last seen	.....	.....	.....	.....
Abundance	Common.	Common.	.....	Common.

30. [204] *Grus americana* (Linn.). Whooping Crane.

"Mr. Charles Dury, of Cincinnati, O., informs me that there is a specimen in the Cuvier Club in that city that was taken near Bloomington, Ind." (A. W. Butler.)

31. [214] *Porzana carolina* (Linn.). Sora.

Rare migrant. B. W. Evermann says it is not often seen and gives two dates—May 5, 1886, and April 15, 1887. C. H. Bollman, '86, records it as a transient. It was also seen May 8, 1900. (N. B. M.)

32 [215] *Porzana noveboracensis* (Gmel.). Yellow Rail.

Not common. (B. W. E. '87.) "Prof. Evermann met with it near Bloomington in August, 1885, where one specimen was taken alive in a marsh" (A. W. Butler).

33. [219] *Gallinula galeata* (Licht.). Florida Gallinule.

Rare migrant. Two specimens taken May 10, 1880, by H. S. Bates.

34. [221] *Fulica americana* Gmel. American Coot.

Rare migrant. April 12 and 26, 1903 (W. L. M.), and April 17, 1900 (N. B. M.).

35. [228] *Philohela minor* (Gmel.). American Woodcock.

Reckoned as a common summer resident in 1886, this bird can now be ranked only as a rare migrant.

MIGRATION RECORD.

Year	1885.	1902.	1903.
Observer	C. H. B.	W. L. M.	W. L. M.
First seen	3-29	3-4	4-19
Next seen			
Common			
Last seen			
Abundance	Common.	Rare.	Rare.

36. [230] *Gallinago delicata* (Ord.). Wilson's Snipe.

Common migrant. March 6 to May 10. September 22 to October 28. Common along all small streams in March and April.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.
Observer	C. H. B.	C. H. B.	B. W. E.	G. G. W.
First seen	4-17		3-15	3-25
Next seen	4-18		3-18	4-2
Common				
Last seen	4-22	9-22	3-25*	4-18*
Abundance	Abundant.	Not common	Common. *W. S. B.	Common. *B. W. E.

Year	1899.	1902.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	P. J. H.
First seen	4-28			3-6
Next seen				
Common		4-18		4-17*
Last seen	5-10		10-28	
Abundance	Common.	Common.	Common.	*W. L. M.

37. [239] *Actodromas maculata* (Vieill.). Pectoral Sandpiper.

Moderately common migrant. March 15 to May 9. This bird seems to have been quite common during the spring of 1885. The bulk of the species departed May 3.

MIGRATION RECORD.

Year	1885.	1886.	1887.	1903.
Observer	C. H. B.	B. W. E.	B. W. E.	W. L. M.
First seen	3-27	3-15	3-15	.....
Next seen	4-19	.....	3-18	.....
Common	4-22	.....	.....	.....
Last seen	5 9	5-5	.....	4-29
Abundance	Common.	.....	.....	Not common

38. [242] *Actodromas minutilla* (Vieill.). Least Sandpiper.

Rare migrant (B. W. E. '87).

39. [246] *Ereunetes pusillus* (Linn.). Semipalmated Sandpiper.

Rare migrant (B. W. E. '87). Twelve were seen April 26, 1903 (H. H. Lane), and one May 3, 1903.

40. [254] *Totanus melanoleucus* (Gmel.). Greater Yellow-legs.

Not observed until the spring of 1903 when it was seen in small numbers on April 26, 29 and 30 and May 1 (W. L. M.). A bird conspicuous by restless actions accompanied by continual and piercing cries.

41. [255] *Totanus flavipes* (Gmel.). Yellow-legs.

One record. Concerning the year 1895, which was remarkable for early arrivals of the Yellow-legs, Butler says: "The last report from southern Indiana that spring was from Bloomington, where it was noted April 26" (Juday).

42. [256] *Helodromas solitarius* (Wils.). Solitary Sandpiper.

Common migrant and perhaps rare summer resident. April 23 to June 9. October 6. This bird has been reported as early as March 20, but these dates should probably be referred to some other species, perhaps Wilson's Snipe. One observer records it as a summer resident while another gives a queried affirmation. The date, June 9, is an extremely late one if the Solitary Sandpiper is to be considered purely as a migrant. But it probably indicates summer residence, since in the Alaskan breeding grounds young have been found in the same month

(June 23, '03, Charlie Creek, Yukon River. W. H. Osgood). A common bird during the migratory season in all muddy places. Seen as early as September 20 in fall. Will probably be found in August.

MIGRATION RECORD.

Year	1886.	1887.	1892.	1899.	1900.	1903.	1903.
Observer	C. H. B.	G. G. W.	E. M. K.	N. B. M.	N. B. M.	W. L. M.	W. L. M.
First seen	5-3	4-28	5-7	4-29	5-3	4-23	.....
Next seen	5-5	4-30	.....	.....	5 4	4-30	.....
Common	.....	.....	.....	.....	5 12	5-3	.....
Last seen	5-7	.....	.....	5-16	5-12	6-9	10-6
Abundance	Rare.	.....	Rare.	.....	.....	Common	.....

43. [261] *Bartramia longicauda* (Bechst.). Bartramian Sandpiper.

Not common transient (C. H. B. '86.).

44. [253] *Actitis macularia* (Linn.). Spotted Sandpiper.

Common migrant and rare summer resident. April 12. There is one egg in the University collection from this locality. Found in the same places as the Solitary Sandpiper but in smaller numbers.

MIGRATION RECORD.

Year	1885.	1892.	1900.	1901.	1903.
Observer	C. H. B.	E. M. K.	N. B. M.	W. L. M.	W. L. M.
First seen	4-22	4-27	4-17	4 12	4-19
Next seen	5-2	5-7	4-28	.....	4-24
Common	5-3	.....	.....	.....	4-28
Last seen	.....	.....	.....	.....	.....
Abundance	Common.	Rare.	.....	.....	Common.

45. [273] *Oxyechus vociferus* (Linn.). Killdeer.* Fig. 6.

Abundant summer resident and rare winter resident. January 31 to Dec. 12. Nest and four eggs found April 12, 1903 (C. E. Edmondson). Another set found May 12, 1903, in a depression in the ground lined with dry grass (C. G. L.). During several dark and cloudy or rainy

nights (March 5 to 13, 1903), the well-known piercing notes of this bird were heard everywhere at all hours. On Nov. 29, '03, a Killdeer was seen on the snow when there was no open water. The few uncovered muddy spots were filled with tracks and probings.

MIGRATION RECORD.

Year	1884.	1885.	1885.	1886.	1886.
Observer	C. H. E.	C. H. E.	C. H. B.	B. W E.	B. W. E.
First seen	3-18	2-28	.....	3-7	.....
Next seen	.....	3-7	.....	3-14	.....
Common	.....	3-19	.....	3-25*	.....
Last seen	.....	.....	12-12	.....	11
Abundance	.....	Abundant.	Abundant.	Common. *W. S. B.	Common.

Year	1892.	1899.	1900.	1901.	1902.
Observer	A. B. U.	N. B. M.	N. B. M.	W. L. M.	W. L. M.
First seen	3-24	3-2	3-9	3-17	3-?
Next seen	4-2	5-3	4-20	3-19*	3-7
Common	.....	.....	.....	3-24	3-26
Last seen	.....	.....	.....	.....	.....
Abundance	Common.	Rare.	Not common	Abundant. *V. H. B.	Abundant.

46. [289] *Colinus virginianus* (Linn.). Bob-white.*

Bob-white is scarcely a common resident at present. In 1886 C. H. Bollmann considered it abundant. May 18, 1903, a nest and two eggs were found in a rather damp spot in a large dense woods and June 14, young ones were seen running about with their mother (C. G. L.). Coveys have been observed rather late; eight were seen April 13, 1902, and seven, May 16, 1903. The so-called "crazy" season was at its height October 11, 1902. A score of instances was noted of their flying in open doors and against windows. More often seen in the woods than in open fields.

47. [300] *Bonasa umbellus* (Linn.). Ruffed Grouse.

As late as 1886 the Ruffed Grouse was a common resident in Monroe County (C. H. B.), and in 1887 was frequently seen in the hills northeast of town (B. W. E.), and was rather common in deep woods (W. S. B.). These phrases are far from indicative of the occurrence of the Ruffed Grouse at present. In four years of continuous field-work but one bird has been observed each year. April 7, 1901, a splendid male was seen; March 23, 1902, one was found dead; Sept. 23, 1902, one flew through a window into a house, and March 14, 1903, one was seen in a dense, tangled and wild tract of woods which was swept by a hurricane several years ago (P. J. H.). It is in this place that the Ruffed Grouse will probably persist longest in this county, and it may be found there in sparing numbers for several years. Three were seen in this locality on April 9, 1904, and two more on April 16. In Brown, the adjoining county east, the Ruffed Grouse was classed as common as late as 1894 (E. M. K.).

48. [316] *Zenaidura macroura* (Linn.). Mourning Dove.* Figs. 7–10.

Common resident, less numerous in winter, though it is sometimes seen in bands of four to twelve in this season. They become common after the first week of March, and the dates are rather regular March 8, '01, March 9, '02, March 8, '03. A bird of even distribution, equally liable to be met with in thickets or more open woods or in plowed lands or weedy fields. A most attractive creature of beautiful appearance and pleasing manner, in the mating season filling the air with the sonorous melody of his love.

The point of greatest interest in regard to the Mourning Dove is its early nesting. Mr. A. W. Butler says: "They begin cooing about the middle of March. * * * They mate early, and their nests, with complement of eggs are often found early in April—April 4, Franklin County." B. W. Evermann found a nest and set of eggs here April 17, 1886. In the last few years, however, nests and eggs have been found at much earlier dates. In 1901, the first nest was found March 17; no eggs were seen, however, until April 7 and April 10. Those found on the latter date were hatched April 14, therefore they must have been laid about on the first and second days of April. The nest was in a tangle of vines on a rail fence. In 1902 the record was as follows: Cooing March 7—nest complete March 27—one egg seen March 28. This

egg and nest were then destroyed by an unfortunate accident. Three other nests were found, however, on the 29th, each of which contained either one or two eggs. All of these nests were placed in small cedar trees. A Dove was heard cooing imperfectly November 9. Doves began cooing in 1903 on March 5. The first nest was found in a cedar, March 22; on April 8 it contained one egg and one young dove just hatched. Reckoning the period of incubation as two weeks, this nest must have had a full set of eggs on March 25 or 26. Another nest was in a pine tree and had young two and one-half inches long on April 11. These were at least a week old, probably more. Then this nest must have contained a full complement of eggs on March 21. On April 24 a nest containing two eggs was found flat on the ground under a mandrake.

49. [325] *Cathartes aura* (Linn.). Turkey Vulture.*

With one exception all the records show that the Buzzard is a resident only a little over nine months in the year, January 31 to November 21. In 1892 E. M. Kindle said that a few were permanent residents. They are quite abundant in this county, and it is not an uncommon thing to see them in companies of ten to sixty gliding about in circling paths in the upper air.

B. W. Evermann found a full set of eggs April 17, 1885. This is earlier than any other date reported from the State. C. G. Littell found young just hatched in a nest in a hollow log in a large, dense and damp woods, May 19, '03. According to the owner of the place Buzzards had roosted at this spot for three years before.

MIGRATION RECORD.

Year.	1885.	1885.	1886.	1892.	1893.	1899.
Observer	C. H. B.	C. H. B.	W. S. B.	E. M. K.	E. M. K.	N. B. M.
First seen	2-7	.....	2-22	2-6	2-22	2-26
Next seen	2-8	.....	2-23*	2-13	2-25	4-1
Common	3-3	.....	.....	2-13*	3-2	4-2
Last seen	.....	11-13	.....	.....	.....	.....
Abundance	Very common.	Abundant.	Common. *B. W. E.	Common. A. B. U.	Common.	Common.

Year.	1900.	1901.	1902.	1902.	1903.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.	
First seen	4-5	2-17	2-26		1-31	
Next seen	4-18	3 3	3-14		2-10	
Common	4-18	3-17	3-20		3-8	
Last seen				11-8		11-21
Abundance	Common.	Abundant.	Abundant	Abundant	Abundant.	Abundant.

50. [326] *Cathartista urubu* (Vieill.). Black Vulture.

Rare spring and summer visitant. "It was noted in Monroe County, 1890" (A. W. Butler). One was seen May 16, 1903.

51. [327] *Elanoides forficatus* (Linn.). Swallow-tailed Kite.

Rare summer visitant. All that have been reported from this county were seen in August, 1885. One was taken on the 4th (C. H. B.), and two were seen of which one was taken on the eighteenth (B. W. E.).

52. [331] *Circus hudsonius* (Linn.). Marsh Hawk.

Rare migrant. The earliest and latest dates of arrival for a series of years are February 28, '85 (C. H. B.), and April 19, '02. It is seen nearly every year, and it was probably common March 14, 1903, when several were seen in a densely wooded creek bottom (P. J. H.).

53. [332] *Accipiter velox* (Wils.). Sharp-shinned Hawk.*

An uncommon resident; common in winter and during the migrations, especially in March and October. W. S. Blatchley reports it as breeding.

54. [333] *Accipiter cooperii* (Bonap.). Cooper's Hawk.*

Resident; not common; breeds. Most numerous in January, February and March.

55. [334] *Accipiter atricapillus* (Wils.). American Goshawk.

Rare winter visitor; one taken November 22, 1885 (G. G. W.).

56. [337] *Buteo borealis* (Gmel.). Red tailed Hawk.*

Common resident; breeds. Nest and eggs April 19, 1903.

57. [339] *Buteo lineatus* (Gmel.). Red-shouldered Hawk.*

Common resident; breeds. This and the last species are somewhat confined to the wilder parts of the country, but are occasionally seen flying over the city.

58. [343] *Buteo platypterus* (Vieill.). Broad-winged Hawk.*

Rather rare resident. Not reported from this county before 1892. More often seen in recent years. Commonest in April and October.

59. [347a] *Archibuteo lagopus sancti-johannis* (Gmel.). American Rough-legged Hawk.

Rare winter visitor; February 21, 1885 (C. H. B.).

60. [349] *Aquila chrysaëtos* (Linn.). Golden Eagle.

Rare winter visitor; a few seen every winter. Has been observed as late as May 15, 1903 (W. L. M.) in Brown County, where it is as likely to remain to breed as in any part of Indiana. Last date for Monroe County, November 28, 1903.

61. [352] *Haliaëtus leucocephalus* Linn.). Bald Eagle.

Rare winter visitor. Considered less rare than the last by W. S. Blatchley and B. W. Evermann. But in recent years the Bald Eagle has not been observed at all, while Golden Eagles have been seen and captured every year. The last date is July 29, 1885 (S. E. Meek). This date suggests a possibility of summer residence of this bird also.

62. [357] *Falco columbarius* Linn. Pigeon Hawk.

Rare migrant, taken several times during 1885-1887, but not observed in recent years. March 12, 1887 (W. S. B.). April 28, 1885 (C. H. B.). November 7, 1885 (G. G. W.)

63. [360] *Falco sparverius* Linn. American Sparrow Hawk.*

Common resident, less numerous in winter; in fact, they are entirely absent some winters as they were during those of 1900-1901, 1902-1903 and 1884-1885. They become common in March—March 15, 1902, March 19, 1903, March 26, 1885 (C. H. B.). They have been observed mating March 17, '03 (W. L. M.), and repairing a nest on the University campus, which has been used for years, on April 11, 1901 and 1903. In years when they do not winter it is seen that the females are the first migrants, as for example, in 1885. The first and second dates for females were March 17 and 20, while males were not seen until March 23 and 24.

64. [364] *Pandion haliaëtus carolinensis* (Gmel.). American Osprey.

Rather rare migrant. March 12 to April 29. November. C. H. Bollmann saw but one in four years, March 12, 1885. B. W. Evermann said it was occasional on the White River ('87), and E. M. Kindle reported it during November, 1892. Of late it has been seen frequently

in the central part of the county; the record for 1903 is as follows: First seen April 13, next April 17, and last April 29.

65. [366] *Asio wilsonianus* (Less.). American Long-eared Owl.

Rare winter visitor. Fall 1886 (B. W. E.); Jan. 30, 1883 (W. S. B.); March 19, 1885 (C. H. B.), are the only dates at hand.

66. [367] *Asio accipitrinus*. (Pall.). Short-eared Owl.

"Very rare; two seen in the fall of 1886" (B. W. E.).

67. [368] *Syrnium varium* (Barton). Barred Owl.*

Considered a common resident by C. H. Bollmann, B. W. Evermann and W. S. Blatchley. The last is authority for a breeding record. I know but little concerning the occurrence of owls in Monroe County. In fact owls are more rare here at present than in any place where I have ever made observations. The only record of a Barred Owl in three years is March 24, 1902, when one was heard. That this condition is only a temporary one is shown by the fact that in the fall of 1900 Screech Owls were abundant and Great Horned and Barred Owls were often heard and seen.

68. [372] *Cryptoglaux acadica* (Gmel.). Saw-whet Owl.*

Rare resident. August 20, 1884. One was taken in the University power plant November 27, 1886 (C. H. B.).

69. [373] *Megascops asio* (Linn.). Screech Owl.*

Common resident. Breeds. The red phase prevails. With the exception of the fall of 1900 this has been a rare bird here in the last few years.

This is the fellow who can best explain the meaning of the series of fan-like scratches which we see after a fresh fall of snow on either side of two parallel rows of tiny dots which end in a little carmine punctuated pit--the shambles of a Peromyscus. A Screech Owl which had the sad affliction of a cataract on one eye was placed in a roomy cage with two whitefooted mice with which to satisfy his appetite. Morning dawned on the scene of an unexpected tragedy. Two mice, with golden coats and pretty white stockings, were nestled in a warm bed of bright rufous feathers, sleeping away the effects of a banquet of owl.

70. [375] *Bubo virginianus* (Gmel.). Great Horned Owl.

Common resident (C. H. B. and B. W. E.). Breeds (W. S. B.). As in the case of the other *Strigs*, rare since 1900. The only recent date is March 22, 1903 (P. J. H.).

The following epitaph is of interest: "'Old Bubo,' the college pet. Caught in a steel trap in September, 1885, and kept in the basement of Owen Hall until January, 1886, when he died."

71. [376] *Nyctea nyctea* (Linn.). Snowy Owl.

Rare winter visitor (C. H. B. '86.). Last date, January 25, 1903 (P. J. H.).

72. [387] *Coccyzus americanus* (Linn.). Yellow-billed Cuckoo.*

Common summer resident. April 13 to Sept. 24. Breeds. A nest of the Yellow-billed Cuckoo was found May 30, 1901. It contained one egg on that day and two on the next. It was in a spice-bush three feet above the ground and was built of sticks and partly lined with leaves (W. L. H.). May 25, 1903, a nest and two eggs were found about seven feet up in a grapevine (C. G. L.). In 1885 a nest with fresh eggs was found as late as June 30, by B. W. Evermann (Butler). "The usual nest is a mere pretense, a flimsy structure of a few sticks, with a few blossoms, generally of the oak, upon which to lay the eggs. Occasionally a very substantial nest is built--one such was found at Bloomington, Ind., by my friend, Mr. O. M. Meyncke" (Butler).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1893.
Observer	C. H. B.	C. H. B.	G. G. W.	E. M. K.	E. M. K.
First seen	5-17		4-13	5-7	5-15
Next seen	5-19		5-5	5-13	5-21
Common	5-24				
Last seen		9-24			
Abundance	Very common.	Very common.	Common. *B. W. E.	Common.	Common.

Year	1899.	1900.	1902.	1902.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-28	5-15	5-5		5-5
Next seen	4-29	5-16			5-10
Common	5-4	5-17	5-10		5-13
Last seen				9-21	
Abundance	Common.	Common.	Common.	Common.	Common.

73. [388] *Coccyzus erythrophthalmus* (Wils.). Black-billed Cuckoo.* Fig. 11.

Common summer resident. May 12 to Sept. 22. Breeds. May 20, 1903, C. G. Littell found a nest and three eggs about eight feet up in a cedar. The nest was a mere platform.

In 1887 B. W. Evermann said that this species was apparently more common than the last. If there is any difference in numbers at present the Black-billed Cuckoo is the more rare of the two species. All records since 1892 show the same state of affairs. In 1894, E. M. Kindle considered this bird rare and the last common in Brown County. At this place the present species is a much more regular migrant than the Yellow-billed Cuckoo. Records of five springs show that it arrived either on the 12th or 13th of May. May 12, 1893, Mr. E. M. Kindle heard them calling as they passed over, and on April 13, 1886, Mr. G. G. Williamson heard the calling of Cuckoos, "Yellow or Black-billed or both." This is much the earliest date that has been recorded for either species within the State. In all probability the birds heard were Yellow-billed Cuckoos, as they are much more irregular than the Black-billed in the time of their arrival and are always observed earlier.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1893.	1902	1903.
Observer	C. H. B.	C. H. B.	B. W. E.	E. M. K.	E. M. K.	W. L. M.	W. L. M.
First seen	5-12	.....	5-13	5-13	5-12	.....	5-12
Next seen	5-16	.....	.....	.....	.....	.....	5-13
Common	5-19	.....	.....	.....	.....	.....	.....
Last seen	.....	9-22	.....	.....	.....	9-21	.....
Abundance	Abund.	Abund.	Very com.	Com.	.....	Com.	Com.

74. [390] *Ceryle alcyon* (Linn.). Belted Kingfisher.

Common summer resident; rare winter resident. March 5 to November 9. Jan. 4, 1893 (E. M. K.). Breeds. The females become numerous in spring before the males.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1897.	1892.	1892-3.
Observer	C. H. B.	C. H. B.	B. W. E.	G. G. W.	E. M. K.	E. M. K.
First seen	3-31		3-22	3-26	3-27	
Next seen	4-3		3-25		4-27	
Common					4-27	
Last seen		11-5				1-4, '93
Abundance	Common.	Very common.	Rare.		Common.	

Year.	1893.	1900.	1902.	1902.	1903.	1903.
Observer	E. M. K.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	3-12	4-18	4-9		3-5	
Next seen	4-26	4-28	4-19		3-6	
Common					4-7	
Last seen				11 9		11-7
Abundance	Common.	Not very common.	Scarce.	Common.	Common.	Common.

75. [393] *Dryobates villosus* (Linn.). Hairy Woodpecker.*

Common resident; breeds. A less familiar bird than the next, but it is occasionally seen in the city. But his contact with civilization generally gives him a dingy color and a ruffled coat.

76. [394] *Dryobates pubescens* (Linn.). Southern Downy Woodpecker.* Fig. 12.

Common resident; breeds. Possibly more common than the last; apparently so because of its more confiding attitude towards man. Nest and one egg in a rail April 23, 1903 (C. G. L.). But the nest has been found with only two eggs in it as late as May 15, 1901.

77. [402] *Sphyrapicus varius* (Linn.). Yellow-bellied Sapsucker.*

Regularly a very common migrant; occasionally a common winter resident. Eight were seen January 21, 1903, in a group of cedars and pines less than an acre in area. It did not winter in 1901-1902. B. W. Evermann gives it as a rare resident, and W. S. Blatchley says it breeds. There are no later dates in spring, however, than May 1, 1903 (W. L. M.), and May 5, 1885 (C. H. B.). It was observed mating April 8, 1903 (W.

There is nothing in the Redhead to suggest the flycatcher, but he really is an expert in that line. A flash of color often attracts your eye to a nearby treetop, and you see that it is the Redhead, who is diminishing the insect population. In one or two or three swoops, as gracefully as Mylarchus himself, he obtains his luncheon.

80. [409] *Centurus carolinus* (Linn.). Red-bellied Woodpecker.*

Common summer resident; less common winter resident. An increase in number is noticeable about the middle of March. Common April 8, 1903.

A very garrulous bird; a single individual often fills the woods with a din of his varied cries; stimulation and excitement are not needed to provoke a demonstration but he seems to do it for the pure love of making a racket.

81. [412a] *Colaptes auratus luteus* Bangs. Northern Flicker.* Fig. 13.

Abundant summer resident and very common winter resident. Becomes abundant in March. Mating call heard as early as February 15, 1903, and as late as November 20, 1902. A nest and two eggs were found in an apple tree April 22, 1903 (C. G. L.).

82. [417] *Antrostomus vociferus* (Wils.). Whip-poor-will.*

Rather common summer resident, but on account of its peculiar habits not commonly observed.

MIGRATION RECORD.

Year	1885.	1886.	1892.	1893.	1899.	1903.
Observer	C. H. B.	W. S. B.	E. M. K.	E. M. K.	N. B. M.	W. L. M.
First seen	5-17	4-21	5-7	4-29	4-25	4-29
Next seen	5-22	4-23*	5-13	5-3	.....	4-30
Common	5-27	.....	.....	.....	.....	.....
Last seen	.....	.....	.....	.....	.....	.....
Abundance	Common.	Common. *C. H. B.	Not common	.....	.....	Common.

83. [420] *Chordeiles virginianus* (Gmel.). Night Hawk.*

Common summer resident. (C. H. B.) April 28 to Sept. 21. Abundant migrant, especially in fall.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1893.
Observer	C. H. B.	C. H. B.	G. G. W.	E. M. K.	E. M. K.
First seen	5-16		5-6	5-6	5-10
Next seen	5-17			5-13	5-12
Common	5-22			5-13	
Last seen		9-21			
Abundance	Abundant	Abundant	Abundant.	Common.	Common.

Year	1899.	1901.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-14	5-20		4-28
Next seen	5-26	5-23		
Common				
Last seen			9-13	
Abundance	Common.	Common.	Abundant.	

84. [423] *Chætura pelagica* (Linn.). Chimney Swift.*

Abundant summer resident. April 4 to October 14. April 4, 1892 (E. M. K.) is as early as it has been reported from the State, while October 14, 1902, is the latest date for the State. On the latter date one was found clinging to a maple tree in the campus. It was quite numb and offered no resistance when picked up. It quickly recovered its vitality in a warm room, however. The outside temperature was 64°.

Nestbuilding April 24, 1903. Nest and five eggs found June 5, 1903 (C. G. L.) in a large chimney about six feet from the top.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1893.
Observer	C. H. B.	C. H. B.	B. W. E.	E. M. K.	E. M. K.
First seen	4-6	.....	4-11	4-4	4-7
Next seen	4-7	.....	4-14*	4-17	4-8
Common	4-17	.....	.....	.....	.....
Last seen	.....	10-13	.....	.....	.....
Abundance	Abundant.	Abundant.	Abundant. *G. G. W.	Common.	Common.

Year	1899.	1902.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-19	4-15	.....	4-8
Next seen	4-20	4-18	.....	4-9
Common	4-26	4-15	.....	4-10
Last seen	.....	.....	10-14	.....
Abundance	Common.	Abundant.	Abundant.	Abundant.

85. [428] *Trochilus colubris* Linn. Ruby-throated Hummingbird.*

Common summer resident. April 29 to September 26. The males migrate about a week ahead of the females. Nest and two eggs May 15, 1902.

MIGRATION RECORD.

Year	1882.	1885.	1885.	1885.	1886.	1892.
Observer	B. W. E.	C. H. B.	C. H. B.	C. H. B.	G. G. W.	E. M. K.
First seen	5-13	4-29	5-8	.....	4-29	4-29
Next seen	.....	4-30	5-9	.....	4-30*	.....
Common	.....	5-13	.....	.....	.....	.....
Last seen	.....	.....	.....	9-14	.....	.....
Abundance	Common.	Abundant.	Abundant	Abundant.	..... *C. H. B.	Not very common.

Year	1900.	1901.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-5	5-4	5-5	.....
Next seen	5-8	5-7	5-6	.....
Common	5-10	5-15	.....	.....
Last seen	.....	.....	.....	9-26
Abundance	Common.	Common.	Moderately common.	Common.

86. [444] *Tyrannus tyrannus* (Linn.). Kingbird.* Fig. 14.

Common summer resident. April 13 to September 5. Mating April 29, 1903. Nest and four eggs on the topmost limb of an apple tree, May 28, 1903 (C. G. L.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	W. S. B.	G. G. W.	E. M. K.
First seen	4-17	.....	4-13	4-24	4-18
Next seen	4-20	.....	4-14*	.....	4-27
Common	4-23	.....	4-15†	.....	4-27
Last seen	.....	9-5	.....	.....	.....
Abundance	Abundant.	Abundant.	Common. *G. G. W. †C. H. B.	.....	Common.

Year	1893.	1900.	1901.	1903.
Observer	E. M. K.	N. B. M.	W. L. M.	W. L. M.
First seen	4-16	4-23	4-30	4-19
Next seen	4-26	4-28	5-4	4-29
Common	.....	.....	5-6	4-29
Last seen	.....	.....	.....	.....
Abundance	Common.	Common.	Common.	Common.

87. [452] *Myiarchus crinitus* (Linn.). Crested Flycatcher.*

Common summer resident. April 18 to September 7. Nestbuilding May 14, 1901; six eggs May 27. In 1902 a nest and 5 eggs were found May 21; the eggs were hatched June 2 and the young birds had flown June 11 (Gertrude Hitze). Another nest with six young about ready to leave was found June 12. It was in a hollow apple tree about 6½ feet up (C. G. L.).

Later in the season, in August and September, these birds may be seen trooping around with a brood of lusty youngsters almost as large as themselves. These little family groups are pleasing objects in the sultry brightness of an open grove or beside the dimly lighted paths of the forest. Myiarchus here, as at all places and all times, seems to fit into his surroundings perfectly. Everywhere he is full of unconscious dignity and is perfectly at home.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	G. H. B.	G. G. W.	E. M. K.	E. M. K.
First seen	4-21		4-23	4-25	4-24	4-18
Next seen	4-22		4-24		4-27	
Common	4-25				4-27	4-26
Last seen		9-7				
Abundance	Abundant.	Very common	Common		Very common.	Common.

Year	1899.	1900.	1901.	1902.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-22	5-6	5-6	4-27	4-28
Next seen	4-28	5-7	5-7	4-28	4-29
Common	5-3	5-8	5-9	4-27	4-29
Last seen					
Abundance	Common.	Common	Common.	Common.	Common.

88. [456] *Sayornis phœbe* (*Lath.*). Phœbe.* Fig. 15.

Common summer resident. March 1 to October 17. An early migrant and an early breeder. B. W. Evermann gives the date March

1, but does not give the year, although it is probably 1887. E. M. Kindle saw it March 2, 1893. They are found first at the nesting places: March 17, 1901, a pair was seen at a quarry; March 14, 1902, one was seen at a bridge near a pond and on the first date in 1903, March 12, they were common at the caves; eleven were seen about the mouths of three caves. Nestbuilding March 22, 1902. Nest complete April 2, 1903. April 12, 1903, a nest and five eggs were found under a bridge (C. G. L.). Well-grown young have been seen May 6, 1899 (N. B. M.), and May 7, 1901.

The Phœbe seems to be better pleased if a suitable nesting site can be found near the dwellings of man. There he lives out his quiet and beneficial career, an unobtrusive yet confiding bird.

MIGRATION RECORD.

Year	1884.	1885	1885.	1886.	1887.	1892.
Observer	C. H. E.	C. H. B.	C. H. B.	W. S. B.	G. G. W.	V. H. B.
First seen	3-18	3-21	.....	3-10	3-20	3-25
Next seen	.....	3-22	.....	3-14*	.....	3-26*
Common	.....	3-31	.....	3-16†	.....	3-29
Last seen	.....	.....	10-17	.....	.....	.....
Abundance	.....	Abundant.	Abundant.	Common.	.....	Common.
				*B. W. E. †Q. G. W.		*E. M. K.

Year	1893.	1899.	1901.	1902.	1902.	1903.
Observer	E. M. K.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	3-2	4-13	3-17	3-14	.....	3-6
Next seen	3-10	5-14	3-24	3-16	.....	3-12
Common	3-10	.....	.....	3-27	.....	3-12
Last seen	.....	.....	.....	.....	10-12	.....
Abundance	Common	Common.	Common.	Common.	Common.	Common.

89. [459] *Nuttallornis borealis* (Swains.). Olive-sided Flycatcher.

Rare transient. April 30, 1885 (C. H. B.). The only other record for the southern part of the State is that of May 12, 1885, Wheatland, Knox County (Robert Ridgway). Do these dates indicate an accidental deviation from the ordinary migration route in that one year?

90. [461] *Contopus virens* (Linn.). Wood Pewee.*

Very common summer resident. April 26 to October 5. Has been reported much earlier, as for instance: April 15, 1899, and April 7, 1900 (N. B. M.), but these records are probably due to wrong identification. The most common Flycatcher.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1893.
Observer	C. H. B.	C. H. B.	C. H. B.	E. M. K.	E. M. K.
First seen	5-3	.....	4-26	5-18	5-6
Next seen	5-5	.....	4-27	.....	.....
Common	5-16	.....	4-28*	.....	.....
Last seen	.....	10-3	.....	.....	.....
Abundance	Abundant	Abundant.	Common. *B. W. E.	Common.	.....

Year	1900.	1902.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-2	4-27	.....	4-28
Next seen	5-8	.....	.....	5-10
Common	5-8	.....	.....	5-10
Last seen	.....	.....	10-5	.....
Abundance	Common.	Common.	.....	Common.

91. [463] *Empidonax flaviventris* Baird. Yellow-bellied Flycatcher.

Rather common migrant. April 17 to August 29. These dates represent the extremes of arrival and departure for the State as well as for the county.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1903.
Observer	C. H. B.	C. H. B.	W. S. B.	A. B. U.	W. L. M.
First seen	4-28	8-26	4-17	5-7	4-28
Next seen	5-1	8-27	.....	.....	4-29
Common	.....	.....	.....	.....	.....
Last seen	5-19	8-29	.....	.....	.....
Abundance	Common.	Common.	.....	.....	Not common

92. [465] *Empidonax virescens* (Vieill.). Green-crested Flycatcher.*

Common summer resident. April 15 to September 18. Considered abundant by C. H. Bollmann and B. W. Evermann in 1886 and 1887. There are four nests, two with eggs, in the University collection.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.
Observer	C. H. B.	C. H. B.	B. W. E.	B. W. E.
First seen	5-14	....	4-27	4-15
Next seen	5-15	.....	5-1*	.....
Common	5-16	.....	5-4†	.....
Last seen	.....	9-18	.....	.....
Abundance	Abundant.	Abundant.	Abundant.	Abundant.
			*C. H. B. †W. S. B.	

Year	1892.	1900.	1903.
Observer	A. B. U.	N. B. M.	W. L. M.
First seen	5-7	5-2	.....
Next seen	.....	5-7	.....
Common	.....	5-8	6-9
Last seen	.....	.....	.....
Abundance	.....	Common.	Common.

93. [466] *Empidonax traillii* (Aud.). Traill's Flycatcher.

"In Monroe County, Prof. Evermann found it an uncommon summer resident" (Butler).

MIGRATION RECORD.

Year	1885.	1885.
Observer	C. H. B.	C. H. B.
First seen	5-14	.....
Next seen	5-15	.....
Common	.....	.....
Last seen	.....	8-27
Abundance	Not rare.	Not common

94. [467] *Empidonax minimus* Baird. Least Flycatcher.*

Common migrant. April 21 to May 19. September 12 to 18. It has been reported by two observers as a summer resident (B. W. E. and N. B. M.), but these records are probably wrong. The bulk of the species departed May 13, '85 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1892.	1899.	1901.	1903.
Observer	C. H. B.	C. H. B.	E. M. K.	N. B. M.	W. L. M.	W. L. M.
First seen	4-21	9-12	5-3	5-5	4-23	4-29
Next seen	4-23	9-13	5-7*	.....	.....	4-30
Common	4-30	9-15	.....	.....	.....	.....
Last seen	5-19	9-18	.....	.....	.....	5-13
Abundance	Abundant	Common.	.....	.....	Common.	Common.
			*A. B. U.			

95. [474b] *Otocoris alpestris praticola* Hensh. Prairie Horned Lark.*

Common resident; more abundant in winter and during the migrations. They became common March 26, 1903. Many notes are given under the name *Otocoris alpestris*, but this is probably due to faulty nomenclature; all such notes were considered as referring to the subspecies, although it is not improbable that *O. alpestris* will be found here in winter.

March 25, 1902. The Horned Larks were singing continually, and one of them was observed in his aerial evolutions. About dusk one began singing all the time, flitting upward a little way, then poised

on stretched and quivering wing, then up again and poising, until he was nearly out of sight. The climax was a straight, swift dive, with wings closed, toward the earth. He did not open his wings until he was within a few feet of the ground, when he settled lightly down and went quietly to feeding as if nothing had happened. Four young were seen just ready to leave the nest May 10, 1903. G. G. Williamson obtained an adult female and a young male May 29, 1886.

96. [477] *Cyanocitta cristata* (Linn.). Blue Jay.* Fig. 16.

Abundant resident; sometimes less numerous in winter.

Jays were nearly all mated March 8, 1903, and a pair was observed mating February 16, 1901. This pair began a nest but abandoned it when about one-fourth completed, February 22. N. B. Myers observed them nestbuilding March 3, 1899. More usual dates are: Nestbuilding, March 17, '03; March 22, '02, a half-completed nest was found; nest completed March 26, 1902, and 1903; three pairs nestbuilding April 1, '01; nests with three eggs were found April 15 and 17, 1903 (W. L. M.). The former was between two rafters in a corncrib and was built partly of mud (C. G. L.). A Blue Jay was seen sitting on unhatched eggs May 16, 1903.

"As spring approaches they become very vocal, uttering many calls, some very pretty notes, varying from loud to low. Evidently some of the latter are intended solely for one female to hear. * * * With us the season of song begins early in March * * * as early as March 8. * * * With it comes pairing time, which I have known them to continue until April 25" (A. W. Butler). As is above stated the Blue Jay has a great number of calls, many of which are principally used during the mating season. But the writer has never heard a Jay give a call during that season that has not been heard during every other month from September to June at some time during the past four years. Careful observations and a separate series of notes have been made with the above conclusion as a result.

On April 28 and 29, 1903, at a time of very abundant nocturnal migration, many Jays were seen migrating by day. They flew steadily and quite high (about 200 ft.), in a northeast direction. The flight of the 29th was exactly similar to that of the 28th; no Jays were even 200 yards from the path. Whether the flight kept up all night is a question. Following are a few groups observed on each day and the approximate time elapsing between their passage of a given point: April

28—12; immediately, 3; 1 minute, 8; 4 minutes, 8; 15 minutes, 11. April 29—3; 2 minutes, 9; 1 minute, 2; etc. The woods below were furnished with their usual numbers of noisy Jays; but neither migrants nor residents seemed to be influenced by the presence of the other.

97. [~~488~~] *Corvus brachyrhynchos* C. L. Brehm. Common Crow.*

The crow is quite common in Monroe County, but the numbers in which it occurs seem insignificant to one accustomed to enormous roosts. Crows are very rarely seen in flocks of as many as one hundred individuals. About 1886 there was quite an extensive roost in Turner's (Cedar) Grove (W. S. B.), but at the present time there is no roost of any size in the county.

The nest has been noted by B. W. Evermann as early as March 20. A half-finished nest was seen April 4, 1903 (C. G. L.). Two nests, one with eggs were found April 20, 1902 (W. L. M.), and a nest with 5 young was found about fifty feet from the ground in a beech, April 26, 1903 (C. G. L.).

98. [~~494~~] *Dolichonyx oryzivorus* (Linn.). Bobolink.*

Common migrant, usually appearing during the first week of May, although it has been observed on April 17, 1885 (C. H. B.) and 1893 (E. M. K.). It may be observed until a month later; May, 17 (C. H. B., '85). August 29 to September 1. The males arrive and depart earlier than the females; males were seen from April 17 to May 5 and females from May 2 to 17, 1885 (C. H. B.).

On a rainy morning in May (5-3-'03) a Bobolink was found in an apple tree in town, singing with all the vivacity of mid-June. This is the first time I have heard it sing during migration.

MIGRATION RECORD.

Year	1882.	1883.	1885.	1885.	1885.	1886.
Observer	B. W. E.	B. W. E.	C. H. B.	C. H. B.	C. H. B.	Bicknell.
First seen	5-6	5-6	♂ 4-17	♂ 5-2	8-29	5-3
Next seen	.....	.....	5-2	5-4	9-1	5-4*
Common	.....	5-6	.....	.....	.....	5-5†
Last seen	.....	.....	5-5	5-17	.....	.....
Abundance	Ratherrare	Common.	Common.	Common.	Common.	Common.

*C. H. B.

†G. G. W.

Year	1887.	1888.	1893.	1901.	1902.	1903.
Observer	G. G. W.	Butler.	E. M. K.	W. L. M.	W. L. M.	W. L. M.
First seen	5-1	5-6	4-17	5-6	5-5	5-2
Next seen	5-4	.....	5-6	5-10	.....	5-3
Common	.....	.....	.....	5-13	5-10	5-14
Last seen	.....	.....	.....	5-13	.....	5-14
Abundance	Common.	.....	.....	Common.	Common.	Common.

99. [495] *Molothrus ater* (Bodd.). Cowbird.*

Abundant summer resident. March 7 to October 17. Eggs found as early as April 22 ('86 B. W. E.). The Cardinal and Indigo Bunting seem to be the coerced foster-parents more often than other birds of this region.

MIGRATION RECORD.

Year	1884.	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. E.	C. H. B.	C. H. B.	B. W. E.	G. G. W.	E. M. K.	E. M. K.
First seen	3-23	4-8	.....	3-7	3-23	3-25	3-11
Next seen	.....	4-9	.....	3-14	.....	4-9	3-19
Common	.....	4-12	.....	.....	.....	4-27	.....
Last seen	.....	.....	10-17	.....	.....	.....	.....
Abundance	.....	Abundant.	Abundant.	Common	.....	Common	Common

Year	1899.	1900.	1901.	1902.	1902.	1903.
Observer	N. B. M.	N. B. M.	V. H. B.	W. L. M.	W. L. M.	W. L. M.
First seen	4-15	4-7	3-23	3-14	.....	3-17
Next seen	4-17	4-12	3-25*	3-25	.....	3-21
Common	4-27	4-28	.....	4-9	.....	3-21
Last seen	.....	.....	.....	.....	9-1	.....
Abundance	Common.	Common.	Common. *W. L. M.	Abundant.	Abundant	Abundant.

100. [498] *Agelaius phœniceus* (Linn.). Red-winged Blackbird.*

Abundant migrant and common summer resident. March 4 to November 16. There are two nests each containing two eggs in the University collection taken by C. H. Bollman, 1885. A bird with striking dress and musical call, as often observed remote from as near bodies of water during the migrations.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	B. W. E.	G. G. W.	E. M. K.	E. M. K.
First seen	3-11		3-4	4-2	3-26	4-26
Next seen	3-14		3-7		4-2*	
Common	3-16				4-12	
Last seen		11-16				
Abundance	Abundant.	Abundant.	Not common		Not common *A. B. U.	Not very common.

Year	1900.	1901.	1902.	1902.	1903.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	3-11	3-17	3-4		3-5	
Next seen	3-22	3-24	3-9		3-6	
Common	3-23	5-4	3-10		3-7	
Last seen				11-4		11-7
Abundance	Not very common.	Abundant.	Abundant.	Abundant.	Abundant.	Abundant.

101. [501] *Sturnella magna* (Linn.). Meadowlark.* Fig. 17.

The Meadowlark is an abundant summer resident and not uncommon winter resident. It becomes abundant at some time from January to March: January 21, 1903 to March 16, 1899 (N. B. M.).

They have been observed gregarious and with no tendency to pairing March 31, and mated April 7 in the same year. The nest with full complement of eggs was found May 1, '03 (C. G. L.); May 7, '01; and four young and an egg were found May 10, '01. They seem to be careless sometimes in regard to the disposal of the eggs. A nest with four young was found May 27, '01 (W. L. H.); two days later the young

were all there, still covered with down, but when the nest was disturbed, two eggs rolled out of the feathers about the nest.

"I have known them in full song March 8. * * * After the harvest is over and the young are able to take care of themselves, most of the Meadowlarks seek choice spots, and but seldom are their songs heard" (Butler). Butler also mentions hearing their song in September and November. The writer has heard them singing every month in the year, nine of which are spent in this region. Following are some dates for Bloomington: 9-28; 10-12; 11-8; 12-18, '02; 1-24; 2-26; 3-2; 4-3; 5-1; 6-9, '03.

The Meadowlark is another bird which migrates considerably by day. The immense, noisy flocks of February and March are always on the move. Fifty of these birds were seen as early as January 21, 1903, flying over due north at a height which made it necessary to use a powerful field-glass to identify them.

This species, as well as most of the members of the family *Icteridae*, is noted for its gregarious habits. That the different species should show such habits *inter se*, as do the swallows, is a more remarkable thing. That this seems to be the case is the only logical conclusion to be drawn from a study of local migration schedules. For instance, for a few days previous to March 21, 1903, Meadowlarks and Grackles, both resident species were the only *Icteridæ* seen. On the 21st, however, these species became augumented in numbers while Rusty Grackles, Redwings and Cowbirds, not seen for several days before, again made their appearance in considerable numbers. This family migration is to be observed in the *Icteridæ* at the time the species become abundant and not at their first arrival. The Orioles move together in the same way and become numerous at about the same time.

102. [506] *Icterus spurius* (Linn.). Orchard Oriole.*

Common summer resident, abundant and conspicuous during the spring migration. April 17 to August 29. These dates are each one day earlier than the recorded limits of its stay in the State. Six years out of ten, this species arrived before the Baltimore Oriole. This is a somewhat different proportion than the two out of fifteen obtained by A. W. Butler. The difference may be explained by a change in habit, as the dates of arrival of the Orchard Oriole before that of its relative are all included in the last seven years in which observations have been made at this point. This change in date of arrival is probably correlated with the

steady increase in numbers in this species and decrease in the next (*vide* Butler, Birds of Ind.. p. 899).

The first song was heard April 28, 1903, and males in the second year plumage were seen singing April 29 and May 10, 1903. The Orchard Oriole is an abundant breeder here; the nest and complement of eggs have been found May 17, 1901.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	C. H. B.	G. G. W.	G. G. W.	E. M. K.
First seen	4-21	.....	4-22	.....	4-24	4-26
Next seen	4-22	.....	4-23*	.....	4-27	.....
Common	4-28	.....	.....	.....	.....	.....
Last seen	.....	8-29	.....	8-14	.....	.....
Abundance	Abundant.	Abundant.	Common.	.....	.....	.....
			*G. G. W.			

Year	1893.	1899.	1900.	1901.	1902.	1903.
Observer	E. M. K.	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-17	4-22	4-24	4-28	4-28	4-24
Next seen	.....	4-27	4-25	4-29	4-30	4-28
Common	.....	4-29	.....	5-3	5-4	4-28
Last seen	.....	.....	.....	.....	.....	.....
Abundance	.....	Common.	Common.	Common.	Abundant.	Abundant.

103. [507] *Icterus galbula* (Linn.). Baltimore Oriole.*

A rather abundant migrant and moderately common summer resident. April 18 to September 2. C. H. Bollman in 1886 and B. W. Evermann in 1887 indicated in their lists that this species was more abundant than the last. The reverse is the case now. A quite regular migrant but it has arrived on the average about a week later since 1890 than it did during the eighties. Not nearly so common a summer resident as the last. Song April 28. 1903. June 8, 1903 nest found hanging in an inaccessible position, on the end of an elm limb about 80 feet from the ground. The bird was incubating I believe (C. G. L.).

MIGRATION RECORD.

Year	1884.	1885.	1885.	1886.	1887.	1892.
Observer	B. W. E.	C. H. B.	C. H. B.	C. H. B.	B. W. E.	E. M. K.
First seen	4-20	4-20	.....	4-20	4-20	4-28
Next seen	.....	4-21	.....	4-22	4-27*	5-7
Common	.....	4-24	.....	4-24*	.....	.....
Last seen	.....	.....	9-2	.....	.....	.....
Abundance	Common.	Abundant.	Abundant.	Common.	.....	Rare.
				*B. W. E.	*G. G. W.	

Year.	1893.	1899.	1900.	1901.	1902.	1903.
Observer	E. M. K.	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-24	4-26	4-18	5-6	4-29	4-28
Next seen	4-25	4-27	4-19	5-7	5-3	4-29
Common	.....	4-28	4-21	5-15	.....	4-29
Last seen	.....	.....	.....	.....	.....	.....
Abundance	Rare.	Common.	Common.	Moder'tely Common.	Moder'tely Common.	Common.

104. [509] *Euphagus carolinus* (Müll.). **Rusty Blackbird.***

Rather common migrant. March 8 to May 16. November 15 to 21.

MIGRATION RECORD.

Year.	1885.	1885.	1886.	1901.	1902.	1903.
Observer	C. H. B.	C. H. B.	B. W. E.	G.Hubbard	W. L. M.	W. L. M.
First seen	3-14	11-15	3-14	3-17	3-16	3-8
Next seen	3-17	11-16	.....	.....	3-25	3-17
Common	3-18	.....	.....	.....	.....	.....
Last seen	4-12	11-21	.....	.....	4-19	5-16
Abundance	Abundant.	Common.	Rare.	.....	Tolerably Common.	Tolerably Common.

105. [511b] *Quiscalus quiscula æneus* (Ridgw.). Bronzed Grackle.*

Abundant summer resident and uncommon winter resident. Following are the numbers seen at some winter dates: 2, 12-30-'84 (C. H. B.), 1-11-'85 (C. H. B.); 1 taken, 1-4-'86 (G. G. W.); and 24, 1-17-1903. Of the last flock, 15 were females, and 9 were males; there were also more females than males in a flock of 30 seen November 30, 1902. On the other hand the first migrants in spring are all great, splendid males in full song. Twenty-six seen February 20, 1903. For a period after the beginning of migration the females are absent. They were not seen until March 8, 1901; March 23, 1902. Grackles become abundant during the first week of March.

A half-finished nest was found April 4 and a nest with three young was found May 13, 1903, in a pine, about 50 feet from the ground (C. G. L.).

Grackles roost in great numbers in the shade-trees of Bloomington and in early spring and in fall many Robins roost in the same places. The calls of the Grackle, both the *chuck* and the metallic notes may be heard at intervals after dark. I have heard them as late as 11 p. m. and as early as 3 a. m. and would not be surprised to learn that they are continued throughout the night.

106. [514] *Hesperiphona vespertina* (Coop.). Evening Grosbeak*.

Very irregular and rare visitor. Seen only in January and April, 1887. Mr. C. H. Bollman took a male on the University campus, January 20, 1887. Mr. G. G. Williamson saw the following numbers during April: 4 on the 27th; 2 on the 29th; and 2 on the 30th.

107. [517] *Carpodacus purpureus* (Gmel.). Purple Finch.

Common migrant and irregular winter resident. B. W. Evermann classes it as a frequent winter visitor and W. S. Blatchley says it wintered in 1882-3. It probably wintered in 1885-6, as no last date is given in the fall migration schedule, nor any first date in that of the spring. The females remain later than the males in spring. I have heard its song at Marion, Ind., March 8, 1900. More often observed in sycamore than in other trees. Most of them departed April 14, 1885 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1901.	1902.	1903.
Observer	C. H. B.	C. H. B.	G. G. W.	W. L. M.	W. L. M.	W. L. M.
First seen	3-14	11-8	.....	3-17	.....	3-8
Next seen	3-27	12-20	.....	3-18	.....	3-18
Common	4-2	.....	.....	.....	.....	.....
Last seen	♂4-25 ♀5-15	.....	4-30	4-7[a]	4-19	5-4
Abundance	Abundant.	.....	.....	Common.	Common.	Common.
				[a]V. H. B.		

108. [521] *Loxia curvirostra minor* (Brehm). American Crossbill.

An exceedingly irregular species; has been found often in winter and has been reported a summer resident.

The Red Crossbill was first reported from Monroe County, February 10, 1883, by B. W. Evermann who says it was common for some time after that date. The same authority also says that it was common during the winter of 1883-4. In both the spring and the fall of 1885 they were quite common. C. H. Bollman's record of its movements in the spring is as follows: 8 males and females seen March 2 and 3; the arrival of the bulk from the north took place March 8 and both sexes were then common; in a letter to J. M. Wheaton he reported them still present March 13; and the last male was seen May 10 and the last female May 12. The bulk of the species departed April 15. From uncatalogued specimens in the collection of Indiana University the following additional dates were obtained: March 10; a male May 14. During the year 1885 it was also reported to have bred at Bloomington. "Mr. Sam Hunter reports a pair to have nested in a pine here in 1885. He says the nest was made exclusively of pine burrs" (E. M. Kindle.).

In the fall of 1885, C. H. Bollman reported the Red Crossbill October 4 and November 5, but gives no date for the last one seen, indicating that it remained throughout the winter, and, indeed, W. S. Blatchley reports it in his list of winter birds as a scarce resident during the winter of 1885-6. In the latter year, the first Crossbills were reported January 18, and fifteen or twenty were seen February 6 (G. G. W.). Crossbills, probably of this species, but not exactly identified were reported February 23

and March 8, 1886. C. H. Bollman saw eleven in a fir tree in Bloomington June 24, and reported them also on July 10, 13 and 14 (B. W. E.).

After being reported quite often during this period of 4 years, Crossbills were not again recorded until 1892, when six were observed by E. M. Kindle and A. B. Ulrey on March 1. The last date recorded for this locality is March 3, 1893 (E. M. K.), when a crossbill probably of this species, was identified by note.

109. [522] *Loxia leucoptera* Gmel. White-winged Crossbill.

A very irregular visitor, much more rare than the last.

White-winged Crossbills were first observed here February 6, 1883. On that date B. W. Evermann took two males from a flock of fifteen in a yard on College Avenue, Bloomington. A female was taken February 10, and "two days later two more specimens were taken near the same place." (A. W. Butler, in "Papers Read at the World's Congress of Ornithology" in Chicago, 1893-6.)

Mr. Evermann also observed this bird February 23 (List of Birds of Carroll County, "Auk," 1889). C. H. Bollman gives a queried record of this species for December 12, 1885. About five were identified by note.

A. W. Butler says: "The only instance of its occurrence in summer in the Ohio valley is that given me by the late C. H. Bollman. He saw eleven in a fir tree in Bloomington, Ind., June 24, 1886." However, on C. H. Bollman's schedule for 1886, this date is attributed to the other species, in the account of which I have placed it.

110. [528] *Acanthis linaria* (Linn.). Redpoll.

Irregular winter visitor.

"B. W. Evermann identified a single bird at Bloomington in December, 1882" (A. W. Butler). C. H. Bollman reports "one seen" in his list of 1886, and "Mr. Chauncey Juday obtained specimens from a flock of twenty at Bloomington, April 12, 1895" (A. W. Butler). W. S. Blatchley also reports one January 30, 1883.

111. [529] *Astragalinus tristis* (Linn.). American Goldfinch.*

Abundant resident.

Song March 29 (W. L. M.,'02). June 12, 1902, a nest and four eggs in a wild rose bush (C. G. L.). October 2, 1903, I shot a young Goldfinch with the short wings and tail and fluffy feathers of a fledgeling, that was unable to fly well and was still being fed by the mother.

The plumage changes are very interesting. It requires about a month for all the males to assume the summer plumage. None were seen

in summer dress until April 18, 1886 (B. W. E.). The record from the first appearance of a change till the moult is completed is as follows: March 29 ('02), two Goldfinches, one singing and in great part in summer plumage; April 1 ('03), eight Goldfinches, four singing and with the back and part of the breast yellow, and part of head black; April 2, four Thistlebirds, one in perfect plumage, the others in changing phases of attire; April 12, two, one in full dress; April 14, five, two in yellow and black; April 19, three, two in winter plumage. One of these which was black; April 19, three, two in winter plumage. One of the last two which was taken was a male, the other one of the trio was in summer attire; April 25, twenty, ten in transitional stages of plumage; April 30, an increase in those of full plumage to the usual summer number. Probably all of the males have completed the moult.

112. [533] *Spinus pinus* (Wils.). Pine Siskin.

A rather regular migrant in moderate numbers; a rare winter resident, October 27 to May 13.

MIGRATION RECORD.

Year	1883.	1885.	1885.	1886.	1886.
Observer	B. W. E.	I. U. Coll.	C. H. B.	G. G. W.	G. G. W.
First seen	2-6	3-23	10-27	.....	.....
Next seen	.....	3-25*	.....	.....	.....
Common	.....	3-25*	.....	.....	12-4
Last seen	.....	5-13*	12-29	4-24	12-20*
Abundance	Not rare.	Common.	Common.	.....	Not common
		*C. H. B.			*W. S. B.

Year	1887.	1896.	1902.	1903.
Observer	G. G. W.	A. W. B.	W. L. M.	W. L. M.
First seen	.....	.....	3-23	.....
Next seen	.....	.....	.....	.....
Common	.....	.....	.....	.....
Last seen	5-8	11-	5-*	3-18
Abundance	.....	.....	.....	.....
			*E. Muhse.	

113. [534] *Passerina nivalis* (Linn.). Snowflake.

Rare and irregular winter visitor (C. H. B., '86).

114. [536] *Calcarius lapponicus* (Linn.). Lapland Longspur.

Rare and irregular winter visitor. Observed February 2, 1883 (W. S. B.); taken February 10 and 12, 1883 (B. W. E.); seven seen February 9, 1901 (V. H. B.). All were associated with *Otocoris a. praticola.*

115. [540] *Poœcetes gramineus* (Gmel.). Vesper Sparrow.*

Abundant summer resident. February 19 to October 25.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	W. S. B.	G. G. W.	A. B. U.	E. M. K.
First seen	4-1		4-8	3-24	4-2	3-30
Next seen	4-2		4-10*	3-25*	4-9*	
Common	4-3				4-17	
Last seen		10-25				
Abundance	Abundant.	Very common.		Abundant.	Common.	Common.
			*G. G. W.	*B. W. E.	*E. M. K.	

Year	1899.	1900.	1901.	1902.	1902.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	2-19	4-18	3-24	2-21		3-17
Next seen	2-24			3-24		3-18
Common	3-25	4-25		3-29		3-17
Last seen					10-19	
Abundance	Common.	Common.	Abundant.	Abundant.	Abundant.	Abundant.

116. [—] *Passer domesticus* (Linn.). European House Sparrow.*

Exceedingly abundant resident. Appeared in Bloomington in 1875 (Butler).

Nest and six eggs taken as early as February 20, '03 (C. G. L.). Two males were observed trying to mate with a female Song Sparrow, March

2, 1901 (W. L. M.). During the mating season English Sparrows often engage in such earnest fighting that one or the other of the contestants is left dead upon the field. Their pugnacious encounters are by no means confined to that season, however. On October 16, 1902, two males were so deeply interested in their battle that they were both easily picked up in the hand.

Flycatchers are found in the Sparrow family and the House Sparrow is one of these. They have been observed catching insects on the wing, swooping and returning to the same perch like Flycatchers. Some seem more adept than others; one seen, made two darts in the air before returning to the tree which was his headquarters. Other Sparrows which have been observed at this pursuit are: Junco, Chewink, Chippy, Field and White-throated Sparrows.

Quite a tendency to albinism is noticeable in this bird and it seems to be of recent development. A perfect albino was taken September 28, 1885 (C. H. B.). In the single spring of 1903, a perfect albino was captured by hand while on a nest containing four young (McCracken); a partial albino with the head and flecks everywhere snowy white was taken and three similar ones seen. Many specimens with one or two rectrices or remiges white were observed. In two months in the summer at another locality, three partial albinos were seen and two complete ones reported. A peculiarity in the coloration is that the light color in the partial albinos is pure snowy white, while the entirely albinistic specimens are deep buffy white.

117. [542a] *Passerculus sandwichensis savanna* (Wils.). Savanna Sparrow.

Common migrant and probably rare summer resident. The majority of migration records do not show this bird in what is probably its true position. There are several rather early spring and late fall reports, but the greater number of dates given nearly coincide with those for the next species as if they were inseparably connected in time of migration as they have been, heretofore, generically united. This bird breeds farther north and winters farther north; the fact that it winters in the lower Wabash valley in our own State makes it seem probable that it should be seen earlier all over the State and that it has probably been overlooked during many seasons until its more conspicuous cousin, with the brighter colors and startling insect-like trill, arrived. It is true that the two birds are generally found together, but it is probable that the obscure

little Savanna Sparrow is present at a given point in the State from a week to a month in advance of the Yellow-winged Sparrow every year.

A nest identified as belonging to a bird of this species by Prof. J. R. Slonaker was found May 17, 1901. It was built in a depression in the ground and was lined and partly arched over with dry grass. On May 22, there were five eggs. June 3, they were hatched. June 7, the nest was empty but probably not as a result of the natural course of events.

In 1885 most of the individuals departed May 2. The Savanna Sparrow was taken March 29, 1894, by E. M. Kindle in Brown County.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.
Observer	C. H. B.	C. H. B.	G. G. W.	E. M. K.
First seen	4-18	10-17	4-10	3-30
Next seen	4-20	.....	4-16	.....
Common	4-22	.....	.....	.....
Last seen	5-11	11-6	4-27*	.....
Abundance	Very common	Not common	Not common	.....
			*B. W. E.	

Year	1901.	1902.	1902.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	.....	3-23	.....	3-17
Next seen	.....	3-24	.....	3-18
Common	5-10	4-3	.....	4-12
Last seen	.....	.....	9-1	.....
Abundance	Common.	Common.	Common.	Common.

118. [546] *Coturniculus savannarum passerinus* (Wils.) Grasshopper Sparrow. Rather common summer resident (B. W. E.). April 12 to Oct. 4.

Song April 12, '03 (W. L. M.). A nest and well incubated eggs found June 6, 1902 (C. G. L.).

MIGRATION RECORD.

Year	1869.	1885.	1885.	1886.	1887.
Observer	I. U. Coll.	C. H. B.	S E. Meek.	B. W. E.	G. G. W.
First seen		4-20		4-25	4-25
Next seen		4-23		4-27	
Common		4-25	8-1	4-27	
Last seen	7-26		10-4		
Abundance		Common.		Rather Common.	
			C. H. B.		

Year	1899.	1901.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-11	5-1	4-19	4-12
Next seen	5-13	5-5	4-25	4-19
Common	5-16	5-6		4-12
Last seen				
Abundance	Common.	Common.	Common.	Abundant.

119. [547] *Ammodramus henslowii* (Aud.). Henslow's Sparrow.

Rare summer resident. Mr. C. G. Littell saw a nest on the ground which contained four young almost ready to fly, June 3, 1902. Mr. Littell made this report in 1903, after he had become better acquainted with the bird at Winona Lake where it was collected. The accuracy of the record is thus assured.

120. [552] *Chondestes grammacus* (Say). Lark Sparrow.

Abundant summer resident. March 26 to August 26. In 1887 B. W. Evermann classed it as rare and said it had not been seen here until in recent years. However C. H. Bollman found it abundant in 1885. The Lark Sparrow has probably been increasing in numbers every year here.

Song April 12, 1903. Mating May 6, 1902. Nest and four young on ground under a cedar limb, May 30, 1903 (C. G. L.).

MIGRATION RECORD.

Year	1884.	1885.	1886.	1886.	1887.
Observer	C. H. E.	C. H. B.	C. H. B.	W. S. B.	G. G. W.
First seen	3-26	4-17	.....	4-21	4-26
Next seen	.....	4-18	.....	4-22*	4-27
Common	.....	4-23	.....	.....	.....
Last seen	.....	.....	5-26	.....	.....
Abundance	.....	Abundant.	Abundant.	Rare.	.....
				*B. W. E.	

Year	1893.	1901.	1902.	1903.
Observer	E. M. K.	W. L. M.	W. L. M.	W. L. M.
First seen	4-17	5-6	4-24	4-12
Next seen	4-19	5-7	4-27	4-19
Common	.....	5-13	.....	4-19
Last seen	.....	.....	.....	.....
Abundance	Not common	Moderately common.	Common.	Abundant.

121. [554] *Zonotrichia leucophrys* (Forst.). White-crowned Sparrow. Moderately common migrant. April 10 to May 16. October 4 to 25. In 1885 most of them departed May 10 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1893.
Observer	C. H. B.	C. H. B.	W. S. B.	G. G. W.	E. M. K.
First seen	5-1	10-4	4-13	4-30	4-19
Next seen	5-2	10-11	4-22*	5-4	4-26
Common	5-4	.....	4-22†	.....	.....
Last seen	5-14	10-25	5-5‡	5-8	.....
Abundance	Very common.	Not common	Common.	.....	.....
			*B. W. E. †B. W. E. ‡G. G. W.		

Year	1900.	1901.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-30	5-5	4-10	4-12
Next seen	5-5	5-6	4-20	4-28
Common	.....	5-7	.....	.....
Last seen	.....	5-15	5-4	5-16
Abundance	.....	Common.	Common.	Common.

122. [558] *Zonotrichia albicollis* (Gmel.). White-throated Sparrow.*

Abundant migrant. March 8, '03 (W. L. M.) to May 16. September 24 to November 22. Possibly rare winter resident. Reported January 29, 1903 (P. J. H.).

Song heard as early as March 9, 1903 and as late as November 8, 1902. On this late date the songs were loud, clear and distinct. "They remain with us in spring as late as they can. Often they are seen mating, and some years, when they lingered long, they have been observed carrying sticks, as though they had thought to begin nest-building. Some year when they remain late, I shall not be surprised to learn that the imperative demands of nature have impelled some of them to make their summer homes with us and build their nests" (A. W. Butler). "April 30, 1902, in a brush heap, in an old orchard, I found a White-throated Sparrow building a nest. The bottom of the nest was made of twigs, but every time she carried any material to the nest, a Catbird would fly down and take it away. The Catbird fought and chased the Sparrows until they left the nest unfinished" (Gertrude Hiltze).

The bulk of the species departed May 10, 1885 (C. H. B.).

MIGRATION RECORD.

Year	1884.	1885.	1885.	1885.	1886.	1887.
Observer	C. H. E.	C. H. B.	C. H. B.	C. H. B.	B. W. E.	G. G. W.
First seen	3-18	3-16	4-8	9-24	4-12	4-11
Next seen	.....	3-18	4-20	10-3	4-17*	.....
Common	.....	4-25	4-25	10-10	4-22	.....
Last seen	.....	5-14	5-15	11-8	5-6	.....
Abundance	.....	Abundant.	Abundant.	Abundant.	Common	.....
					*G. G. W.	

Year	1892.	1900.	1901.	1902.	1902.	1903.	1903.
Observer	A. B. U.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	....	4-17	.....	3-9	10-5	3-8	.....
Next seen	.....	.....	.....	3-14	10-12	3-9	.....
Common	.....	.....	.....	3-25	10-26	3-20	. .. .
Last seen	4-30	.....	5-13	5-4	11-9	5-16	11-22
Abundance	.....	.....	Common	Common	Common	Abundant.	Abundant.

123. [559] *Spizella monticola* (Gmel.). Tree Sparrow.*

Abundant winter resident. October 12 to April 19. The song is often heard in spring: March 1 and 5, 1902, and March 9 and 17, 1903.

MIGRATION RECORD.

Year	1885.	1885.	1901.	1902.	1902.	1903.
Observer	C. H. B.	C. H. B.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	.....	11-4	.....	.....	10-12	....
Next seen	.....	11-15	.....	.....	10-19	.....
Common	3-23	12-26	.....	.....	11-28	.....
Last seen	4-19	.....	3-17	3-26	....	3-17
Abundance	Abundant.	Abundant.	Common.	Very Common.	Common.	Abundant.

124. [560] *Spizella socialis* (Wils.). Chipping Sparrow.* Fig. 18.

Abundant summer resident. March 16 to November 9.

Song March 17, 1903; March 26, 1902. Mating March 27, 1903. Nest found April 28, 1899 (N. B. M.); nest and four eggs May 2, 1903 (C. G. L.). Nearly full grown young seen with mother and being fed by her May 29, 1903. There is a nest in the collection of the University which is composed of soft vegetable fibers or rootlets without a trace of horsehair.

MIGRATION RECORD.

Year	1884.	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. E.	C. H. B.	C. H. B.	W. S. B.	G. G. W.	E. M. K.	E. M. K.
First seen	3-24	4-1		3-19	4-1	3-27	3-20
Next seen		4-2				4-9	3-23
Common		4-3		5-24*			
Last seen			11-7				
Abundance		Abund't.	Abund't.	Common		Common	Common

*G. G. W.

Year	1899.	1900.	1901.	1902.	1902.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-12	4-8	3-25	3-16		3-27
Next seen	4-15	4-12	3-27	3-23		3-18
Common		4-17		3-26		3-20
Last seen					11-9	
Abundance	Common.	Common.	Common.	Common.	Common.	Abundant.

125. [563] *Spizella pusilla* (Wils.). Field Sparrow.* Fig. 19.

Abundant summer resident. February 26 to November 8. Possibly rare winter resident. Reported January 17 and February 2, 1903 (P. J. H.).

Singing weakly February 26, 1902; in full song March 10, 1903. Mating March 29, 1902. Nest and 3 eggs, May 3, 1903 (C. G. L.). This nest was on the ground at the base of a large weed. Nest and full set of eggs May 14, 1899; hatched May 18 (N. B. M.).

A most abundant species in weedy fields.

MIGRATION RECORD.

Year	1884.	1885.	1885.	1886.	1887.	1893.
Observer	C. H. E.	C. H. B.	C. H. B.	B. W. E.	G. G. W.	E. M. K.
First seen	3-18	3-31	.....	3-15	3-24	3-30
Next seen	.....	4-1	.....	3-25	.....	.....
Common	.....	4-2	.....	3-26	.....	.....
Last seen	.....	.....	11-8	.....	.....	.....
Abundance	.....	Abundant.	Abundant.	Common.	.....	Common.

Year	1899.	1901.	1902.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	.....	3-17	2-26	.....	3-1
Next seen	.....	3-24	3-14	.....	3-3
Common	4-15	3-24	3-21	.....	3-15
Last seen	.....	.....	.....	11-5	.....
Abundance	Common.	Common.	Common.	Common.	Abundant.

126. [567] *Junco hyemalis* (Linn.). Slate-colored Junco.*

Abundant winter resident. October 6 to May 1.

Snatches of song are often heard in March and April and it has been heard singing in the fall; November 9 and 23, 1902. On November 23, 1902, a bright, sunshiny day, one of three Juncos was observed carrying dry blades of grass in its beak. It always gave them up in favor of new ones every little while and did not put many of them in the same place. On this same day a Junco was also heard singing a quite loud and pleasing song. This occurrence should probably be classed with those phenomena which were discussed under the heading, "A Revival of Sexual Instinct" in "The Auk" a year or more ago. A similar thing has been noticed in the case of the English Sparrow. One was seen nest-building November 6, 1902.

Where there are weeds there are Juncos. But briary fence rows, and thicketed gullies are centers of density in the Junco population.

MIGRATION RECORD.

Year	1885.	1892.	1899.	1901.	1902.	1902.	1903.
Observer	C. H. B.	E. M. K.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	10-6					10-12	
Next seen	10-7					10-14	
Common	10-20					10-19	
Last seen		4-21	4-6	4-14	4-27		5-1
Abundance	Abundant.			Abundant.	Abundant.	Abundant.	Abundant.

127. [575a] *Peucæa æstivalis bachmanii* (Aud.). Bachman's Sparrow.

Common migrant and not uncommon summer resident. April 6, —.

"April 24, 1884, Prof. W. S. Blatchley took two Bachman's Sparrows from a brush-pile in Monroe County. That was its first record there. It appeared regularly thereafter between April 6 (1885) and April 29 (1886). In 1886 two sets of eggs and perhaps a half-dozen taken (Evermann)" [A. W. Butler]. Song April 7, 1903. Common April 12, 1903; 31 of these birds were seen in a single high, brushy meadow. Here and in clearings where there are many oak saplings and in the uneven pastures where rosebushes and stunted cedars are plentiful, Bachman's Sparrow is most often found.

MIGRATION RECORD.

Year	1884.	1885.	1886.	1887.	1902.	1903.
Observer	W. S. B.	C. H. B.	C. H. B.	G. G. W.	W. L. M.	W. L. M.
First seen	4-24	4-6	4-29	4-27	4-19	4-7
Next seen		4-26	5-8*	4-28	4-20	4-8
Common						4-12
Last seen						
Abundance		Not rare.	Not rare. *G. G. W.		Rare.	Common.

128. [581] *Melospiza cinerea melodia* (Wils.). Song Sparrow.* Fig. 20.

Abundant during migration; common at other times but more so in winter than in summer. The Song Sparrow is not a common breeder here.

The most common songster, whose value is enhanced by his habit of singing when most other birds are silent. The writer has heard Song

Sparrows singing every month in the year. Following are dates when their song was heard in this locality, for ten months of the year: 9-28; 10-12; 11-8; 12-14, '02; 1-21; 2-22; 3-4; 4-4; 5-1; 6-9, '03. On April 8, 1900, one was observed singing during flight. Though not a performer of intricate music, nor ostentatious either in his lay or his pretty self, to the person to whom are familiar our country lanes as they appear in the cool, quiet duskiness of vernal evenings, this domestic songster is the most welcome and the most cheerful and cheering of singing birds.

May 3, 1903, nest and four young in a small, thick cedar in a sinkhole (C. G. L.). Many nests and eggs are found during the first week in June.

129. [583] *Melospiza lincolnii* (Aud.). Lincoln's Sparrow.

Rare migrant; probably a more common and regular one, however than can be inferred from the data at hand.

MIGRATION RECORD.

Year	1885.	1885.
Observer	C. H. B.	C. H. B.
First seen	5-3	10-10
Next seen	5-5	10-11
Common		
Last seen		10-25
Abundance	Not common	Not common

130. [584] *Melospiza georgiana* (Lath.). Swamp Sparrow.

Common migrant. March 5 to April 29, October 2 to November 3. "Reported by B. W. Evermann in winter, not seen by me before March 19" (W. S. B.). There is a possibility that the Swamp Sparrow is an occasional summer resident. A nest in the University collection from this locality is identified as belonging to this bird.

In speaking of the breeding grounds, A. W. Butler says: "There it sings its song, but during the migrations it is songless." P. J Hartman and the writer saw and heard the Swamp Sparrow singing during a steady drizzling rain March 8, 1903, the first date for the bird in that year.

MIGRATION RECORD.

Year	1885.	1886.	1887.	1895.
Observer	C. H. B.	W. S. B.	G. G. W.	Butler.
First seen	10-17	3-19	3-26	3-5
Next seen	10-28	.....	.....	.....
Common	.....	.....	.....	.....
Last seen	11-3	.....	.....	4-19
Abundance	Common.	.....	.....	.....

Year	1902.	1902.	1903.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	3-26	10-12	3-8	.....
Next seen	3-27	.....	3-9	.....
Common	.....	.....	.....	.....
Last seen	4-24	10-26	4-29	10-2
Abundance	Common.	Common.	Common.	Common.

131. [585] *Passerella iliaca* (Merr.). Fox Sparrow.*

Common to abundant migrant. February 20 to May 16. October 5 to November 28. Rare winter resident. January 17, 1903. In winter they are very restricted in their range. Though seen several times from November 28, 1902, to March 8, 1903, none were seen outside of a portion of the valley of Griffey Creek about one fourth of a mile long. The exceedingly late date, May 16, 1903, is a record of six or seven Fox Sparrows seen by the Nature Study Class and the writer along a creek bottom in the extreme eastern part of the county.

"It is said to have a clear, loud, melodious voice, and to sing a sweet song, which I have never heard, but hope to some spring, as they should occasionally give us a foretaste of the musical treat that is wasted—humanly speaking—on the uninhabited Hudson Bay Region" (A. W. Butler). The song of the Fox Sparrow is indeed loud and melodious and is in tone similar to that of the Chewink. I have heard it singing every spring that I have made observations in this locality. P. J. Hartman and myself heard the song many times during the spring of 1903. They began singing March 9.

The bulk departed April 12, 1885 (C. H. B.).

MIGRATION RECORD.

Year	1884.	1885.	1885.	1886.	1892.	1895.
Observer	C. H. E.	C. H. B.	C. H. B.	B. W. E. G. G. W. W. S. B.	E. M. K. A. B. U.	A. W. B.
First seen	3-19	3-18	10-'0	3-14	2-20	.....
Next seen	.....	3-27	10-14	3-16	2-27	.....
Common	.....	3-31	.....	.....	.....	.....
Last seen	.....	4-19	11-3	3-25	3-30	4 20
Abundance	.....	Common.	Rare.	Common.	Common.	.....

Year	1901.	1902.	1902.	1903.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	3-24	3-1	.....	.....	.....
Next seen	.....	3-2	.....	.....	.....
Common	.....	3-23	10-5	3-8	.....
Last seen	.....	4-16	10-28	5-16	11-22
Abundance	Common.	Common.	Common.	Abundant.	Common.

132. [587] *Pipilo erythrophthalmus* (Linn.). Towhee.* Fig. 21.

Abundant migrant and summer resident; common winter resident. There is always a noticeable period in spring when Chewinks are very scarce. This is probably due to the departure of our winter residents before the arrival of migrants and summer residents. A marked example of this period of scarcity is found in the record for the spring of 1902. Up to the fifteenth of February, males and females were common and present in about equal numbers. From this date until the ninth of March, no Chewinks were seen. On the latter date, and for nearly a week thereafter, although males were present, no females were seen. But on the twenty-fourth of March both sexes were equally abundant and the season of song was at its height. Thus in this spring there was a period twenty-three days in length when they were absent; a period of a week when males only were present; and finally another period of fifteen days during which the arrival of other birds brought the numbers up to the usual summer abundance. This hiatus is more or less marked in every

year's record. That the males migrate first to the breeding ground is also upheld by all other available data.

MIGRATION RECORD.

Year.	Male.	Female.	Observer.
1885	3-14	4-1	C. H. B.
1886	2-22*	3-9	W. S. B.
1902	3-9	3-16	W. L. M.
	*B. W. E.		

The Chewink begins singing early. The first perfect song was heard March 1, 1903. On February 20, however, and again on March 1, two of these birds were found rehearsing in low tones. The first was scratching among some briars and was going over his spring song very softly. The notes were exactly the same; the only difference was in the volume and the tone which seemed to express contentment rather than ecstacy. The other one, heard on the first of March, was sitting in some cedar brush with his feathers ruffled up, his bill sunk in his breast, muttering his score. This whole effort was accomplished in rather a drowsy manner and he was so oblivious to his surroundings, that he was not frightened by the presence of a human being within three feet of him. Immediately after this, I heard another Chewink give the song perfectly from the top of a chestnut tree. It was a beautiful chant and seemed unusually attractive on this rainy March morning. The same habit of rehearsal has been observed in several other birds, among which are the Song Sparrow, White-throated Sparrow and Brown Thrasher.

Nest and three eggs found April 15, '03. Birds hatched on June 11, 1901, had flown June 19 (W. L. H.).A very late date is given by B. W. Evermann. "August 19, 1881, I found a Chewink's nest containing three fresh eggs, built at least three feet from the ground in a spice bush. Such is not common I believe." (Orn. and Oöl., 1881.)

133. [593] *Cardinalis cardinalis* (Linn.). Cardinal.* Fig. 22.

Abundant resident.

Mating February 18, 1901; March 23, 1903. Nestbuilding April 12, 1903, but, on the same date a nest was found which contained three eggs. This was afterwards ascertained to be the full set.

The Cardinal is another one of those cheery birds which may be heard singing at all times of the year. Some winter dates of singing are: 10-19; 11-9, '02 and 1-1; 2-8, '03. On February 13, 1903, I heard a Cardinal singing from the top of a cedar tree at 6 a. m., and on passing the same place at 7 a. m. found him still at his music.

134. [595] *Zamelodia ludoviciana* (Linn.). Rose-breasted Grosbeak.*

Common migrant. "But few breed here" (B. W. E.). Although the Rose-breasted Grosbeak has been reported a summer resident from localities farther south than this (St. Louis, Cincinnati), such an occurrence is very unusual. The only record of its making its summer home at Bloomington is that of B. W. Evermann in 1886. Song May 8, 1903.

The date, November 12, 1888, is from an uncatalogued specimen in the Museum of Indiana University which was collected by a Mr. Chambers. The males seem to arrive earlier and depart later than the females. Neither so common nor so early a migrant now as formerly.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886.	1887.
Observer	C. H. B.	C. H. B.	C. H. B.	B. W. E.	G. G. W.
First seen	4-23	4-30	9-11	4-23	4-28
Next seen	4-26	5-5	9-17	4-24*	.....
Common	5-6	5 6	9-18	5-4	.....
Last seen	6-16	5-15	10-10	5-4	.....
Abundance	Abundant.	Abundant.	Abundant.	Common. *W. S. B.	.....

Year	1888.	1901.	1902.	1903.
Observer	Chambers.	W. L. M.	W. L. M.	W. L. M.
First seen	.....	5-7	5-5	5-7
Next seen	.....	.....	.....	5-8
Common	.....	.....	.....	.....
Last seen	11-12	.....	.....	.....
Abundance	.....	Common.	Common.	Common.

135. [598] *Cyanospiza cyanea* (Linn.). Indigo Bunting.*

Abundant summer resident. April 13 to October 17; which are the limits of its stay in the State.

Song April 29, '03; also heard as late as August 9, in a latitude but little south of this. May 19, '03, nest and one egg found in a small bush along a road (C. G. L.). The males migrate from a few days to two weeks in advance of the females.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1882.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	C. H. B.	B. W. E.	C. H. B. W. S. B. G. G. W.	G. G. W.	E. M. K.
First seen	4-25	5-9	.....	4-13	4-22	4-27	5-4
Next seen	5-2	5-10	.....	.....	4-23	4-30	.....
Common	5-16	5-16	.....	.....	4-24	.....	.....
Last seen	.....	.....	10-17	.....	.....	.....	.....
Abundance	Abundant.	Abundant.	Abundant.	Abundant.	Abundant.	.....	.....

Year	1893.	1895.	1900.	1901.	1902.	1902.	1903.	1903.
Observer	E. M. K.	A. W. B.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-6	5-2	4-28	5-6	.....	.....	4-28	.....
Next seen	.....	.....	.....	5-7	.....	.....	4-29	.....
Common	.....	.....	.....	5-14	5-4	.....	4-29	.....
Last seen	.....	.....	.....	.....	.....	9 1	.....	10-6
Abundance	.....	.....	Common	Common	Common	Common	Abundant	Abundant

136. [604] *Spiza americana* (Gmel.). Dickcissel.

Abundant summer resident. April 23 to October 2.

Song May 5, 1903. Nest and 5 eggs in a low bush, in an old orchard, May 15, 1901. Nest and four eggs about three feet up in a bush in a pasture, June 2, 1902 (C. G. L.).

Both sexes arrive at the same time, and they are either mated upon arrival or mate very soon afterwards.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	C. H. B. G. G. W.	G. G. W.	A. B. U.	E. M. K.
First seen	4-30		4-23	5-2	5-7	4-28
Next seen	5-1		4-29			5-4
Common	5-10		5-1			
Last seen		10-2				
Abundance	Abundant.	Abundant.	Abundant.			

Year	1895.	1899.	1901.	1902.	1903.
Observer	A. W. B.	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-4	5-11		5-4	5-5
Next seen		5-13			5-10
Common		5-16	5-15	5-10	5-16
Last seen					
Abundance			Common.	Common.	Abundant.

137. [608] *Piranga erythromelas* Vieill. Scarlet Tanager.*

Common migrant. Moderately common summer resident (B. W. E., '87). April 22 to September 19. Song and mating April 29, 1903. Usually the males arrive before the females, sometimes as much as a week in advance. They arrive at the same time, however, in some years. B. W. Evermann says that this species was moderately common here in the spring of 1881. Six were seen on one morning in May. He says that this was the farthest north it had been reported in the State up to that time.

MIGRATION RECORD.

Year	1882.	1885.	1885.	1885.	1886.
Observer	B. W. E.	C. H. B.	C. H. B.	C. H. B.	B. W. E. G. G. W.
First seen	5-6	4-26	5-3		4-22
Next seen		4-28	5-9		4-23
Common		5-10	5-10		4-24
Last seen				9-19	
Abundance		Abundant.	Abundant.	Abundant	Common.

Year	1887.	1892.	1902.	1903.
Observer	G. G. W.	E. M. K.	W. L. M.	W. L. M.
First seen	4-28	5-4	4-23	4-28
Next seen	4-29	.....	4-27	4-29
Common	.....	.....	.....	4-29
Last seen	.....	.....	.....	.....
Abundance	.....	.....	Common.	Common.

138. [610] *Piranga rubra* (Linn.). **Summer Tanager.***

Abundant migrant and common summer resident. April 1 to September 28.

Mated May 4, 1903; nest and five eggs in a small apple tree near a pond. May 19, 1902 (C. G. L.); nest and four eggs May 29, '01.

The date, April 1, 1886, is from an uncatalogued specimen in the museum of Indiana University, by W. A. Millis. The first migrant in 1901 was a male in variegated plumage. The males precede the females in migration.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	C. H. B.	C. H. B. B. W. E.	G. G. W.	A. B. U. E. M. K.	E. M. K.
First seen	4-22	4-26	.....	4-18	4-27	5-1	5-1
Next seen	4-25	5-2	.....	4-18	.....	5-28	.....
Common	5-3	5-3	.....	5-4	.....	.....	.....
Last seen	.....	.....	9-28	.....	.....	.....	.....
Abundance	Abundant.	Abundant.	Abundant.	Common.	.....	.....	.....

*W. A. Millis.

Year	1899.	1900.	1901.	1902.	1902.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-9	4-29	5-6	4-27	.....	4-28
Next seen	5-11	5-5	5-7	5-4	.....	5 2
Common	5-16	5-9	5-13	4-27	.....	5-10
Last seen	.....	.....	.....	.....	9-1	.....
Abundance	Common.	Common.	Common.	Common.	Common.	Common.

In 1894 E. M. Kindle remarked upon the absence of this bird from Brown County while it was common in this, the adjoining county. During the last spring (1903) the Summer Redbird was common also in Brown County.

139. [611] *Progne subis* (Linn.). Purple Martin.*

Common summer resident. March 28 to September 10.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.	1895.
Observer	C. H. B.	C. H. B.	B. W. E. G. G. W.	G. G. W.	A. B. U. E. M. K.	E. M. K.	A. W. B.
First seen	3-31	.....	3-28	3-29	3-31	3-31	4-17
Next seen	4-1	.....	4-9	.....	4-2	.....	.....
Common	4-6	.....	.....	.....	4-19	.....	.....
Last seen	.....	9-10	.....	.....	.....	.....	.....
Abundance	Abundant.	Abundant.	Common.	.....	Common.	Common.	.....

Year	1899.	1900.	1901.	1902.	1902.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-12	4-7	4-16	4-5	.....	3-28
Next seen	4-13	4-8	4-17	4-6	.....	4-2
Common	4-20	4-10	4-18	4-15	.....	4-11
Last seen	.....	.....	.....	.....	9-1	.....
Abundance	Common.	Common.	Common.	Common.	Common.	Abundant.

There are only two large ponds in the region, and as the Swallows are seen at these places for a long time before they are in any other part of the country it is easy to record their migration.

One of the peculiarities of their migration is the arrival at the same time of all or several of the species. On one day we can find no Swallows at all; on the next, perhaps, all, from the Martin to the little Bank Swallows, will be present about our ponds. Four of the species came on the same day in 1885, and three on the same day in 1902 and 1903. After their arrival they are augmented in numbers at the same time, or they leave, or arrive again in full strength. Thus on four days in April, 1903—the 10th, 13th, 19th and 30th—large mixed flocks were observed, when all or nearly all of the species had been

absent the day before. Their departure was similar. On April 11, 17, 27 and May 1, the less vagrant summer resident *Progne* was the only Swallow remaining of the motley companies of the day before. In other years this mode of migration has been just as marked; in 1902, two species arrived together on the fifth of April and three on the thirteenth; and in 1885, four species, the Bank, Tree, Barn and Cliff Swallows arrived in one flock on the 15th of April, and were seen together again on the next day. Tree and Cliff Swallows became common on the 22d, the Barn Swallow a day before, and on the 25th the Bank and Roughwinged Swallows became common.

A more detailed discussion of the migration of the *Hirundinidæ* in 1903, will bring out another point, i. e., the relation of weather conditions to the phases of the migratory movement.

From April 10, the date when three species had arrived, to May 3, inclusive, when the last flock of migrants was seen, there were just fifteen cloudy or rainy days, with an average temperature of 47° at 5 a. m., and ten clear days with a temperature of 44.° Swallows, sometimes, with the exception of the Purple Martin, were absent [three specimens of *Hirundo* seen one day and two of *Petrochelidon* another] during the ten days, and were very much in evidence fifteen days. South winds prevailed during this period and migration was high among all the small land birds, especially on the 28th and 29th; but on these dates no flocks of swallows were seen. If a clear or partly clear period was succeeded by a rainy, cloudy, or misty one, swallows were surely to be found. As long as the weather remained cloudy, these birds remained, but on the first fair day they disappeared. The only species that arrived on a clear day was the Tree Swallow; but after its arrival its movements agreed with those of its cousins. There was only one cloudy day on which the crowds of swallows were absent and even that day brought an increase in the number of Martins.

A synopsis of the period follows: April 10, cloudy, 3 species; April 11, cloudy, an increase in number of Purple Martins; April 12, fair, no Swallows (Martin ignored); April 13-16, inclusive, cloudy and rainy, all species present; April 17-18, clear, no Swallows; 19-25, inclusive, cloudy or rainy, all species present in considerable numbers; 26-29, fair, few Swallows seen and their number decreased during this period; April 30, cloudy, a large flock of four kinds; May 1-2, clear, no Swallows; May 3, rainy, a

flock of eighty Bank Swallows and twelve Purple Martins. After this date only the usual summer numbers of the breeding species were seen; there were no more migrants. The Purple Martin which seemed to be less affected by weather conditions after arrival than the other species, was orthodox in its arrival which occurred on a cloudy morning after a clear night.

There is no other record so complete; and it can not be stated whether this relation between weather and migration is a fixed one, but in regard to the migratory movements of Swallows in 1903, it may be said that the relation was so close that one could predict the numbers to be found on any day from the condition of the weather.

140. [612] *Petrochelidon lunifrons* (Say). Cliff Swallow.

Abundant migrant and common summer resident. April 12 to September 14. Nest and four eggs in University collection (C. H. B.).

MIGRATION RECORD.

Year	1884.	1885.	1885.	1886.	1887.
Observer	A. W. B.	C. H. B.	C. H. B.	C. H. B.	G. G. W.
First seen	4 18	4-15	....	4-19	4-12
Next seen	....	4-16	....	4-22	....
Common	....	4-22	....	....	....
Last seen	....	....	9-14	....	....
Abundance	....	Abundant.	Abundant.	Abundant.	....

Year	1893.	1895.	1901.	1902.	1903.
Observer	E. M. K.	A. W. B.	W. L. M.	W. L. M.	W. L. M.
First seen	5-2	4-17	5-7	4-13	4 13
Next seen	5-6	....	....	....	4-14
Common	....	....	....	....	4-14
Last seen	....	....	....	....	....
Abundance	....	....	Common.	Common.	Common.

141. [613] *Hirundo erythrogastra* Bodd. Barn Swallow.

Abundant migrant and summer resident. April 9 to September 12. May 12, 1903, nest about two-thirds completed on a rafter in a loft of a barn (C. G. L.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	G. G. W.	G. G. W.	A. B. U. E. M. K.
First seen	4-15		4-10	4-12	4-18
Next seen	4-16		4-17		4-19
Common	4-21		4-20		4-24
Last seen		9-12			
Abundance	Abundant.	Abundant.	Common.		Common.

Year	1893.	1899.	1902.	1903.
Observer	E. M. K.	N. B. M.	W. L. M.	W. L. M.
First seen	4-9	4-22	4-13	4-10
Next seen	4-10		4-19	4-13
Common				4-13
Last seen				
Abundance	Common.	Common.	Common.	Abundant.

142. [614] *Iridoprocne bicolor* (Vieill.). Tree Swallow.

Abundant migrant. April 5 to 30. A common summer resident in 1886 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1902.	1903.
Observer	C. H. B.	W. L. M.	W. L. M.
First seen	4-15	4-5	4-5
Next seen	4-16	4-19	4-10
Common	4-22		4-5
Last seen			4-30
Abundance	Very common.	Common.	Abundant.

143. [616] *Riparia riparia* (Linn.). Bank Swallow.*

Abundant migrant and common summer resident. April 6. Young learning to fly, June 4, 1902 (C. G. L.).

MIGRATION RECORD.

Year	1884.	1885.	1900.	1902.	1903.
Observer	A. W. B.	C. H. B.	N. B. M.	W. L. M.	W. L. M.
First seen	4 6	4-15	4-17	4-13	4-13
Next seen		4-16	4-20		4-14
Common		4-25	4-20		4-22
Last seen					
Abundance		Common.	Common.	Common.	Abundant.

144. [617] *Stelgidopteryx serripennis* (Aud.). Rough-winged Swallow.

Common migrant and rather common summer resident. April 13. B. W. Evermann found them abundant and mating at Gosport, May 8, 1886. Many nests were nearly complete.

MIGRATION RECORD.

Year	1885.	1886.	1903.
Observer	C. H. B.	B. W. E. W. S. B.	W. L. M.
First seen	4-18	5-1	4-13
Next seen	4-22	5-8	4-14
Common	4-25	5-8	4-22
Last seen			
Abundance	Common.	Rare.	Common.

145. [619] *Ampelis cedrorum* (Vieill.). Cedar Waxwing.

Common summer resident; irregular at other seasons of the year, sometimes entirely absent for considerable periods, and again appearing in large numbers for a longer or shorter time.

Nest and two eggs about six feet up in an isolated cedar, June 13, 1902 (C. G. L.).

146. [621] *Lanius borealis* Vieill. Northern Shrike.

Although stated to be a rare winter visitor by C. H. Bollman in 1886, there are no actual records for this region except those of February 8, and 23, 1902. It was observed in Brown County, November 18, 1894 (E. M. K.).

147. [622c] *Lanius ludovicianus migrans* (W. Palmer.). Migrant Shrike.*

Uncommon summer resident. March 3 to December 1. Rare in winter (W. S. B.). February 16, 1901 (V. H. B.).

Mating and attempts at song, March 15, 1903. The song resembles some of the more harsh calls of the Blue Jay. May 10, 1903, nest and five young just hatched, ten feet up in a hedge (C. G. L.).

MIGRATION RECORD.

Year	1885.	1886.	1892.	1893.	1901.
Observer	C. H. B.	W. S. B.	A. B. U.	E. M. K.	W. L. M.
First seen	4-1	3-28	3-25	3-15	3-3
Next seen	4-17				3-17
Common					
Last seen					
Abundance	Rare.	Rare.		Rare.	Common.

Year	1902.	1902.	1903.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	3-23		3-11	
Next seen			3-15	
Common				
Last seen		11-30		12-1
Abundance	Common.	Common.	Common.	Common.

148. [624] *Vireo olivaceus* (Linn.). Red-eyed Vireo.* Fig. 23.

Abundant migrant and summer resident. April 19 to October 2.

Song April 28, 1903; mating April 29. Nest with three eggs of the owner and one of a Cowbird, May 25, '03. This nest was about four feet high, attached to a limb of a small cedar bush and thickly surrounded by blackberry vines.

This far from shy bird with its persistent song is found absolutely everywhere in the height of its migration. It sings as long as it is here; one was heard singing September 20, 1903.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	B.W.E. C.H.B.	G. G. W.	E. M. K.	E. M. K.
First seen	4-21		4-23	4-27	4-27	5-1
Next seen	4-22		4-24			
Common	4-25					
Last seen		10-2				
Abundance	Abundant.	Abundant.	Abundant.		Common.	Common.

Year	1899.	1900.	1902.	1902.	1903	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-26	5-2	4-23		4-19	
Next seen	4 29	5-7	4 25		4-27	
Common	4-29	5-8	4-27		4-29	
Last seen				9-28		9-20
Abundance	Common.	Common.	Common.	Common.	Abundant	Abundant.

149. [626] *Vireo philadelphicus* (Cass.). Philadelphia Vireo.

Rare migrant. April 28th to September 28th. The dates are earlier and later respectively than the hitherto recorded extremes of the Philadelphia Vireo's stay in Indiana. Rare summer resident (B. W. E., '87).

MIGRATION RECORD.

Year	1885.	1885.	1903.
Observer	C. H. B.	C. H. B.	W. L. M.
First seen	4-30		4-28
Next seen	5-4		
Common			
Last seen		9-28	
Abundance	Rare.	Rare.	Rare.

150. [627] *Vireo gilvus* (Vieill.). Warbling Vireo.*

Common summer resident. April 21 to October 10. Song April 28, 1903.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1903.
Observer	C. H. B.	C. H. B.	C. H. B. B. W. E.	G. G. W.	A. B. U.	W. L. M.
First seen	4-21		4-25	4-28	5-7	4-28
Next seen	4-22		4-27			4-29
Common	4-28					4-28
Last seen		10-10				
Abundance	Abundant.		Common.			Common.

151. [628] *Vireo flavifrons* Vieill. Yellow-throated Vireo.*

Common migrant. April 16 to May 13; September 1 to October 19; the extreme dates are the limits of its residence in the State. Perhaps rare summer resident; its nest was found in Brown County, May 16, 1897 (V. H. B.). Song April 29, 1903. In the fall of 1902 Yellow-throated Vireos were found wherever there was undergrowth.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1896.
Observer	C. H. B.	C. H. B.	B. W. E. C. H. B.	G. G. W.	A. W. B.
First seen	4-20	9-12	4-16	4-25	4-20
Next seen	4-22	9-15	4-17		
Common					
Last seen	5-13	9-28			
Abundance	Common.	Common.			

Year	1901.	1902.	1902.	1903.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-6	4-25	9-1	4-24	
Next seen		4-27	10-5	4-28	
Common			10-19		
Last seen			10-19		9-29
Abundance		Common.	Common.	Common.	Common.

152. [629] *Vireo solitarius* (Wils.). Blue-headed Vireo.

Rather uncommon migrant. April 28 to May 17. September 16 to 28.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1895.	1903.
Observer	C. H. B.	C. H. B.	G. G. W.	E. M. K.	A. B. U.	W. L. M.
First seen	4-28	9-16	5-1	5-9	4-28	4-29
Next seen	4-30	9-18	.....	.....	.....	5-13
Common	.....	.....	.....	.....	.....	.....
Last seen	5-17	9-28	.....	.....	.....	5-13
Abundance	Common.	Rare.	.....	.....	.....	Rare.

153. [631] *Vireo noveboracensis* (Gmel.). White-eyed Vireo. Fig. 24.

Abundant summer resident. April 17 to September 20.

Song April 28, 1903, to September 20, 1903. May 5, 1903, a nest was nearly completed. It was found along a narrow, little-frequented road, and was attached on one side to a cedar limb, and to a blackberry vine on the other. It was about four feet high. On April 11, this nest contained two Cowbird's eggs and one of the Vireo (C. G. L.).

Abundant and vociferous in the spring migration. Every thicket is filled with the jargon of its song.

The date of April 17, 1903, is given on the authority of a Nature Study Class.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	C. H. B. B. W. E. G. G. W.	G. G. W.	A. B. U.
First seen	4-21	.....	4-25	4-25	5-7
Next seen	4-22	.....	4-28	4-26	.....
Common	4-25	.....	5-8	4-30	.....
Last seen	.....	9-2	.....	.....	.....
Abundance	Common.	Common.	Common.	Common.	.....

Year	1893.	1899.	1900.	1903.	1903.
Observer	E. M. K.	N. B. M.	N. B. M.	W. L. M.	W. L. M.
First seen	4-30	5-1	4-21	4-17*	.....
Next seen	5-6	5-4	.....	4-24	.....
Common	.....	.....	.....	4-29	.....
Last seen	.....	.....	.....	.....	9-20
Abundance	.....	.....	.....	Abundant.	Abundant.

*See above.

154. [636] *Mniotilta varia* (Linn.). Black and White Warbler.*

Common migrant and rare summer resident. Considered a common summer resident in 1886 by C. H. Bollmann. April 7 to October 4. Song April 28, 1903.

In spring you will find this striped vision only on the trunks of the larger forest trees. Although you are searching for him and feel sure of his presence, the actual discovery is always a surprise. This little flake of sharply contrasted colors makes its appearance so quickly that we find it difficult to realize that it is not a piece of bark suddenly possessed of life, but our own dear little Black and White Creeper that is before us. In Autumn he is more democratic and is often found in lowly thickets. Is it not because we are sated with discovery, that the thrill of last spring is not felt when this leader of the band of wood warblers is espied? Is it not because we have met the timid glance of the rare Cape May, or the gaudy Magnolia through the interlacing branches, or that here the Redstart spins his glowing pin-wheel, that the Black and White Warbler is not again hailed as a distinguished visitor when we see him in September clinging to the slender stem of the hazel, inspecting its surface or gracefully reaching out for the slow-descending caterpillar?

Yes, we think the reason lies with the observer and not with the observed; for we are surely not at our best when we slight our tiny friend ever so little in the greeting. He remains always the most attractive, the most dear of his woodsy clan.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1893.
Observer	C. H. B.	C. H. B.	G. G. W. C. H. B.	G. G. W.	E. M. K.
First seen	4-17	.....	4-17	4-20	4-7
Next seen	4-18	.....	4-18	4-27	.....
Common	4-24	.....	.....	.....	.....
Last seen	.....	9-28	.....	.....	.....
Abundance	Common.	Common.	Common.	.....	.....

Year	1901.	1902.	1902.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-4	4-27	9-1	4-24
Next seen	.....	.....	9-7	4-28
Common	.....	.....	.....	4-28
Last seen	.....	.....	10-4	.....
Abundance	.....	Common.	Common.	Common.

155. [637] *Protonotaria citrea* (Bodd.). Prothonotary Warbler.

Rare migrant. "Mr. Chauncey Juday reports it from Monroe County, where a specimen was taken at Harrodsburg, April 26, 1895" (A. W. Butler). E. M. Kindle reported it May 28, 1892. As nests and eggs of this species have been taken in other parts of the State at an earlier date than this, it is possible that the Prothonotary Warbler may be found here as a rare summer resident.

156. [639] *Helmitheros vermivorus* (Gmel.). Worm-eating Warbler.

Common migrant and "rather common summer resident" (B. W. E.). April 20 to August 31. Song May 4, 1902. "Prof. W. S. Blatchley took a nest and six fresh eggs, and one of the Cowbird, near Bloomington, May 12, 1886. The nest was at the base of a clump of ferns, and was composed of the leaves of 'Maiden Hair' fern. The next day Prof. B. W. Evermann took a nest from a similar location, containing five of the owner's eggs and two of the Cowbird" (A. W. Butler).

Common in the fall of 1903 in the undergrowth along creeks.

MIGRATION RECORD.

Year.	1885.	1885.	1886.	1902.	1903.
Observer	C. H. B.	C. H. B.	W. S. B. B. W. E.	W. L. M.	W. L. M.
First seen	4-20	.....	5-1	4-27	4-28
Next seen	4-21	.....	5-4	5-4	.....
Common	.....	.....	.....	.....	4-28
Last seen	.....	8-31	.....	.....	.....
Abundance	Common.	Common.	Rare.	Common.	Common.

157. [641] *Helminthophila pinus* (Linn.). Blue-winged Warbler.*

Abundant migrant. Rare summer resident (C. H. B.—B. W. E.). April 19 to September 28. Song April 19, 1903.

Orchards and open woods are the favorite haunts of the Blue-winged Yellow Warbler.

On a bright day after a rainy morning in April, 1903, warblers of this species were observed to move from one part of the country to another about three miles away in from six to eight hours. In the morning they were plentiful in the orchard and clearings south of the city, while none were to be observed anywhere north of town. In the afternoon these conditions were reversed, they were common and singing in the orchards north of town, while they were entirely absent in the places where they had been seen in the morning. Their movements even for the shortest distances were always in the same direction, they flew from limb to limb, from tree to tree, in the same general trend, toward the north.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1902.	1902.	1903.
Observer	C. H. B.	C. H. B.	B. W. E.	G. G. W.	W. L. M.	W. L. M.	W. L. M.
First seen	4-20	.....	4-27	4-28	4-23	.....	4-19
Next seen	4-28	.....	.....	4-29	.....	.....	4-28
Common	.....	.....	.....	.....	.....	.....	4-19
Last seen	.....	8-31	.....	.....	.....	9-28	.....
Abundance	Rare.	Rare.	Common.	.....	Common.	Common.	Abundant.

158. [642] *Helminthophila chrysoptera* (Linn.). Golden-winged Warbler.

Very rare migrant. April 27, 1887 (G. G. W.); 28, 1901; May 4, 1886 (G. G. W.).

159. [645] *Helminthophila rubricapilla* (Wils.). Nashville Warbler.*

"Common in spring, abundant in fall" (C. H. B., 1886). "In Monroe County it was rather common, April 27 to May 1, 1886 (Evermann, Blatchley)" [A. W. Butler]. During the last few years the Nashville Warbler has been a more rare bird than the above quotations indicate. One or two records in a migration has been as much as could be hoped for concerning this species. April 24 to May 11. August 26 to October 10.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1899.
Observer	C. H. B.	C. H. B.	B. W. E. W. S. B.	N. B. M.
First seen	4-25	8-26	4-27	5-5
Next seen	4-26	9-22		
Common				
Last seen	5-11	10-10	5-1	
Abundance	Common.	Abundant.	Common.	

Year	1901.	1902.	1903.	1903.
Observer	C. H. E.	W. L. M.	W. L. M.	W. L. M.
First seen	4-29	4-24	4-29	
Next seen				
Common				
Last seen				10-2
Abundance	Rare.	Rare.	Rare.	Rare.

160. [646] *Helminthophila celata* (Say). Orange-crowned Warbler.

Very rare migrant. One record; May 4, 1885 (C. H. B.).

161. [647] *Helminthophila peregrina* (Wils.). Tennessee Warbler.*

"Not common in spring, abundant in fall" (C. H. B., 1886). April 26 to May 16. August 30 to October 17. "At Bloomington, both Profs. Blatchley and Evermann thought it less numerous than the Nashville Warbler" (A. W. Butler). Decidedly the reverse is the case now. One

may observe in spring a hundred of the present species to one of the Nashville Warbler, and in fall a thousand. The Tennessee Warblers, in the latter season, literally fill all the trees, whether the neatly-trimmed maples along the city streets or the magnificent oaks of the forest. The underbrush is alive with them, they are in the weeds, in briars, and in the stubble. Swamp and hilltop, cultivated field and forest, alike, are animated by the hordes of Tennessee Warblers. They are everywhere.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1890.	1900.	1903.	1903.
Observer	C. H. B.	C. H. B.	C. H. B	A. W. B	N. B. M.	W. L. M.	W. L. M.
First seen	4-26	4-30	4-27				
Next seen	4-30	9-4					
Common		9-11		5-3			
Last seen	5-14	10-7		5-10	5-12	5-16	10-2
Abundance	Rare.	Abundant.	Rare.	Common		Rare.	Abundant.

162. [648a] *Compsothlypis americana usneæ* Brewster. Northern Parula Warbler.

Rare migrant.

In accordance with A. W. Butler's precedent, birds from Monroe County are referred to this subspecies.

MIGRATION RECORD.

Year	1885.	1886.
Observer	C. H. B.	G. G. W. W. S. B.
First seen	4-21	4-24
Next seen		4-27
Common		
Last seen		
Abundance	Rare.	Rare.

163. [650] *Dendroica tigrina* (Gmel.). Cape May Warbler.

Rather rare migrant. April 22 to May 11. September 27 to October 7.

In the fall of 1903, the writer observed this species and the Tennes-

see Warbler puncturing grapes. They thrust their bills into the grapes and after poking around inside a little lifted their heads and acted as if drinking. After being punctured, the grapes, of course, shrivelled and became worthless. Scarcely a grape, and not a cluster were missed in the arbor under observation. The damage, however, was not great, as the birds did not begin their depredations until after the owners had harvested as much of the crop as they desired.

The males arrive and depart earlier than the females.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886	1899.	1903.
Observer	C. H. B.	C. H. B.	C. H. B.	C. H. B. G. G. W.	N. B. M.	W. L. M.
First seen	4-22	4-24	9-27	4-24	.....	.....
Next seen	4-23	4-30	.....	5-1	.....	.....
Common	.....	.....	.....	5-5	.....	.....
Last seen	5-8	5-11	10-7	5-5	5-8	9-29
Abundance	Rare.	Rare.	Rare.	Rare.	.....	Rare.

164. [652] *Dendroica æstiva* (Gmel.). Yellow Warbler.*

Abundant summer resident. April 12 to August 24.

Song April 26, 1903; mating April 27. Nest and eggs May 4, 1902. May 30, 1903. Nest with four, well-incubated eggs, in the top fork of a small plum tree about 20 feet from the ground (C. G. L.).

Very common in orchards; a persistent songster.

The earliest record for the State is April 4, 1894 (E. M. K.), from Brown County.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	B. W. E. C. H. B. G. G. W.	G. G. W.	A. B. U.
First seen	4-21	.....	4-22	4-25	4-30
Next seen	4-22	.....	4-23	.....	.....
Common	4-24	.....	5-1	.....	.....
Last seen	.....	8-24	.....	.....	.....
Abundance	Abundant	Abundant.	Rare.	.....	.....

Year	1893.	1899.	1901.	1902.	1903.
Observer	E. M. K.	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-26	4-29	5-6	4-19	4-12
Next seen	.....	.....	.....	4-23	4-24
Common	4-26	4-29	.....	4-27	4-27
Last seen	.....	.....	.....	.....	.....
Abundance	Common.	Common.	.....	Common.	Abundant.

165. [654] *Dendroica cærulescens* (Gmel.). Black-throated Blue Warbler.

Rather uncommon migrant. April 30 to May 13. September 1 to October 4.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1902.	1903.
Observer	C. H. B.	C. H. B.	G. G. W.	G. G. W.	W. L. M.	W. L. M.
First seen	4-30	9-18	5-7	5-2	9-1	4-30
Next seen	5-3	.....	.....	.....	9-28	.....
Common	.....	.....	.....	.....	.....	.....
Last seen	5-13	.....	.....	.....	10-4	5-12
Abundance	Common.	Rare.	.....	.....	Rare.	Rare.

166. [655] *Dendroica coronata* (Linn.). Myrtle Warbler.*

Common migrant and not rare winter resident. September 24 to May 13. First in full plumage March 25, 1903. In winter this species seems to prefer certain restricted localities; most of the individuals that have been seen here in winter have been found in a dense pine and cedar grove, but in the winter of 1902-1903, some were seen at two other places—an open forest near a pond and an old orchard.

Recorded as wintering in 1882-3; 1884-5; 1885-6; 1886-7; 1891-2; 1892-3; 1899-1900; 1900-01; 1902-3.

The record of the appearance of individuals in different stages of plumage for a year is as follows: those seen at intervals through January, February and part of March were in the usual winter dress. On the tenth of March (1903) the first change was noted. A single Yellowrump

was found in some bushes along a street in town. The side-spots were large and brilliant as was also the rump. The back had the sharply defined black and gray streaking, but the head and breast were as in winter. March 21, a specimen in winter plumage was seen; March 23, two individuals, one in full plumage with the exception of the crown-spot which was somewhat obscured by dark tips to the feathers, the other in the usual autumnal and winter garb. March 25, four Myrtle Warblers were seen, and of these, one had the winter plumage, two had yellow crown and rump but no side-spots, and one was brilliant in a new and complete spring suit. March 27, one with winter colors; March 30, one in complete and one in winter plumage; April 1, two like the last. April 3, three specimens with all the spots showing but only dimly on the sides and crown. After April 3 all mentioned are in full plumage unless otherwise stated. April 5, two, one in winter dress; April 8, four, one in winter plumage; April 11, four; April 12, twelve; April 14, three, two of which were clothed as in winter; April 15, four; April 19, six, one looking just as he did in January, and he was the last one observed in this plumage, although of twenty-one seen on April 28, two were still in transition stages of plumage. Thus fifty days elapsed between the first and last observed changes in plumage, and, half as many days passed between the appearance of summer dress and the vanishing of winter garb.

In the fall the first yellowrumps were seen on October 12 (1902). Of thirty individuals, one had the sides yellow, while all of the others had already assumed the sombre shades of winter plumage. October 26, fourteen of these birds were observed and one was still in nearly perfect summer condition, the crown and sides being only slightly dusted with darker. All others seen during the remainder of the year were in ordinary winter plumage. From these observations it may be seen that, although about eight months are consumed in the change from winter, through summer, back to winter plumage again, by the species as a whole, yet it is possible that some individuals may complete this cycle of changes in six months.

On December 14, 1902, a Myrtle Warbler was seen flying in somewhat wide sweeps, like a flycatcher, but, hovering, he gleaned from the trees, fences and the ground, and not from the air.

MIGRATION RECORD.

Year.	1883.	1884.	1885.	1885.	1885.	1887.
Observer	B. W. E	C. H. E.	C. H. B.	C. H. B.	C. H. B.	G. G. W. B. W. E.
First seen	2-10	3-21	4-31	4-25	9-24	2-
Next seen			4-17	4-30	9-25	
Common			5-2	5-8	10-7	
Last seen			5-11	5-13		5-4
Abundance	Common.		Abundant	Abundant.	Abundant.	Common.

Year.	1892.	1900.	1901.	1902.	1902.	1903.
Observer	A. B. U.	N. B. M.	W. L. M. C. H. E	W. L. M.	W. L. M.	W. L. M.
First seen	2-19			3-23	10-12	
Next seen	3-31			3-38	10-26	
Common			4-29		10-12	4-12
Last seen		4-29	5-1	4-27		5-3
Abundance	Common.		Common.	Common.	Common.	Common.

167. [657] *Dendroica maculosa* (Gmel.). Magnolia Warbler.*

Rather common migrant. May 5 to 24. August 31 to October 4. In woods with undergrowth, you will find this warbler spying upon you from the lower limbs of the maples and beeches, or peeping through the network of leaves and branches of the thickets. He always has the attitude of peering. His black spectacles set off with white dots only enhance this expression.

Females were not seen until May 8, 1885.

MIGRATION RECORD.

Year.	1885.	1885.	1886.	1887.	1889.	1902.
Observer	C. H. B.	C. H. B.	G. G. W.	G. G. W.	N. B. M.	W. L. M.
First seen	5-5	8-31	5-8	5-5	5-10	9-1
Next seen	5-8	9-6	5-14			9-7
Common		9-12				9-28
Last seen	5-24	9-19	5-14			10-4
Abundance	Common.	Common.			Rare.	Common.

168. [658] *Dendroica cerulea* (Wils.). Cerulean Warbler.

Common migrant; not common summer resident (G. G. W.—N. B. M.). The males precede the females in migration.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.
Observer	C. H. B.	C. H. B.	W. S. B. C. H. B.	G. G. W.
First seen	♂ 4-28	♀ 5-9	4-23	4-27
Next seen	5-4	5-10	4-24	4-28
Common	.....	.....	.....	.....
Last seen	.....	.....	.....	.....
Abundance	Common.	Common.	Common.	Common.

Year	1892.	1900.	1901.	1903.
Observer	A. B. U.	N. B. M.	W. L. M.	W. L. M.
First seen	4 30	5-5	5-4	4-28
Next seen	5-7	.....	.....	.....
Common	.....	.....	.....	.....
Last seen	.....	.....	.....	.....
Abundance	.....	Common.	Common.	Common.

169. [659] *Dendroica pensylvanica* (Linn.). Chestnut-sided Warbler.

Rather common migrant. April 21 to May 10. August 28 to September 15.

The first migrants are males.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886.	1892.	1901.	1902.	1903.
Observer	C. H. B.	C. H. B.	C. H. B.	G. G. W. B. W. E.	A. B. U.	C. H. E.	W. L. M.	W. L. M.
First seen	♂ 4-21	♀ 4-28	8-28	5-4	5-7	4-29	5-5	5-7
Next seen	4-28	4 30	8-29	5-8	.....	.....	.....	.....
Common	.....	.....	8-31	.....	.....	.....	.....	.....
Last seen	5-10	.....	9-15	.....	.....	.....	.....	.....
Abundance	Common	Common	Common	Common	.....	.....	.....	Rare.

170. [660] *Dendroica castanea* (Wils.). **Bay-breasted Warbler.**

Rather rare migrant. April 29 to May 13. September 18 to October 10. The limiting dates each extend the recorded period of its stay in Indiana one day.

MIGRATION RECORD.

Year	1885.	1886.	1903.	1903.
Observer	C. H. B.	B. W. E. G. G. W.	W. L. M.	W. L. M.
First seen	9-18	5-4	4-29	.....
Next seen	9-19	5-6	.....	.....
Common	10-3	.....	.....	.....
Last seen	10-10	5-8	5-13	10-3
Abundance	Abundant.	Rare.	Rare.	Rare.

171. [661] *Dendroica striata* (Forst.). **Black-poll Warbler.**

Rather rare migrant. April 28 to May 19. September 18 to October 26.

The last date for the species in 1885, May 19, was the date of arrival of the females. October 26, is the latest record for this State. The last one taken in 1903 was a female.

MIGRATION RECORD.

Year	1885.	1885.	1902.	1903.
Observer	C. H. B.	C. H. B.	W. L. M.	W. L. M.
First seen	4-28	9-18	.....	.....
Next seen	5-13	9-19	.....	.....
Common	.....	9-25	.....	.....
Last seen	5-19	10-12	10-26	5-13
Abundance	Rare.	Abundant.	Rare.	Rare.

172. [662] *Dendroica blackburniæ* (Gmel.). **Blackburnian Warbler.**

Rather rare migrant. April 21 to May 14. August 27 to October 10.

MIGRATION RECORD.

Year	1885.	1885.	1895.	1886.
Observer	C. H. B.	C. H. B.	C. H. B.	B. W. E.
First seen	4-21	5-13	8-27	4-27
Next seen	5-2	5-14	8-30	.....
Common	.....	.....	.....	.....
Last seen	5-14	5-14	10-10	.....
Abundance	Common.	Common.	Rare.	Rare.

Year	1892.	1901.	1902.	1903.
Observer	A. B. U.	W. L. M.	W. L. M.	W. L. M.
First seen	5-7	5-7	9-1	4-28
Next seen	.....	.....	.....	.....
Common	.....	.....	.....	.....
Last seen	.....	.....	.....	.....
Abundance	.....	Rare.	Rare.	Rare.

173. [663a] *Dendroica dominica albilora* Ridgw. Sycamore Warbler.*

Common migrant; not uncommon summer resident (B. W. E., '87). April 12 to October 9.

Song and mating April 12, 1903.

On September 18, 1902, it seemed that every shade tree in town contained five or six of these birds; sometimes they descended and fed for a short time in the lawns. Some were also seen feeding upon ragweeds.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1892.	1893.
Observer	C. H. B.	C. H. B.	B. W. E. A. W. B.	E. W. K.	E. W. K.
First seen	4-21	.....	4-14	4-21	4-16
Next seen	4-24	.....	4-16	.....	.....
Common	.....	.....	4-27	.....	.....
Last seen	5-16	9-27	.....	.....	.....
Abundance	Common.	Rare.	.....	.....	.....

Year	1901.	1902.	1902.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-5	4-23	.....	4-12
Next seen	.....	4-27	.....	4-19
Common	.....	4-23	9-28	4-28
Last seen	.....	.....	10-9	.....
Abundance	Common.	Common.	Common.	Common.

174. [667] *Dendroica virens* (Gmel.). Black-throated Green Warbler.*

Abundant migrant. April 18 to May 16. September 1 to October 17. These dates indicate a longer stay in this county than has heretofore been recorded for the State.

In spring this species is nearly confined to the woods, in fall it is found everywhere.

The males arrive and depart earlier than the females.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	C. H. B.	G. G. W. C. H. B. B. W. E.	G. G. W.	E. M. K.
First seen	4-20	5-5	9-11	4-18	4-25	.....
Next seen	4-21	5-9	9-12	4-22	4-28	.....
Common	5-9	5-9	9-18	4-23	.....	.....
Last seen	5-13	5-14	10-17	5-4	5-7	5 7
Abundance	Abundant	Abundant.	Abundant.	Common.	.....	.....

Year	1901.	1902.	1902.	1903.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	.....	.....	9-1	4-27	.....
Next seen	.....	.....	9-7	4-28	.....
Common	.....	.....	.....	4-27	.....
Last seen	5-7	5-4	10-5	5-16	10-2
Abundance	Common.	Common.	Common.	Abundant.	.....

175. [671] *Dendroica vigorsii* (Aud.). Pine Warbler.

Rare migrant. April 23-26. September 4-29.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1902.	1903.
Observer	C. H. B.	C. H. B.	W. S. B.	W. L. M.	W. L. M.
First seen	4-23	.....	4-26	.....	.....
Next seen	.....	.....	.....	.....	.....
Common	.....	.....	.....	.....	.....
Last seen	.....	9-27	.....	9-7	9-29
Abundance	Rare.	Rare.	.....	Rare.	Rare.

176. [672] *Dendroica palmarum* (Gmel.). Palm Warbler.*

Common migrant. April 25 to May 13. September 22-27. "Rare in 1886 but usually a common migrant" (C. H. B., '86).

Found in orchards and open woods.

The males appear to migrate slightly in advance of the females.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886.
Observer	C. H. B.	C. H. B.	C. H. B.	C. H. B. W. S. B. G. G. W.
First seen	4-23	4-25	9-22	4-24
Next seen	4-25	5-2	.....	4-26
Common	5-3	5-3	.....	.....
Last seen	5-13	5-13	9-27	5-6
Abundance	Common.	Common.	Not Common.	Rare.

Year	1887.	1902.	1903.
Observer	G. G. W.	W. L. M.	W. L. M.
First seen	.....	4-27	4-30
Next seen	.....	.....	5-1
Common	.....	.....	5-3
Last seen	5-4	.....	5-5
Abundance	.....	Rare.	Common.

177. [673] *Dendroica discolor* (Vieill.). Prairie Warbler.

Rare migrant. April 26 to May 16. Song May 12 and 16, 1903. Has always been found in deeply-thicketed woods.

MIGRATION RECORD.

Year	1885.	1900.	1903.
Observer	C. H. B.	N. B. M.	W. L. M.
First seen	4-26	5 5	5-12
Next seen			5-16
Common			
Last seen			
Abundance	Rare.		Rare.

178. [674] *Seiurus aurocapillus* (Linn.). Oven-bird.

Common summer resident. April 19 to October 12. Formerly abundant (C. H. B., 1886).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1901.
Observer	C. H B.	C. H. B.	C. H. B.	W. L. M.
First seen	4-19		4-22	5-7
Next seen	4-20		4-24	
Common	4-25			
Last seen		10-3		
Abundance	Abundant.	Abundant.	Common.	Common.

Year	1902.	1902.	1903.	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-20		4-28	
Next seen				
Common				
Last seen		10-12		9-20
Abundance	Common.	Common.	Common.	Common.

179. [675] *Seiurus noveboracensis* (Gmel.). Water-Thrush.

Common migrant. March 27 to May 5. September 14 to 18. Song April 12, 1903.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1900.	1902.	1903.
Observer	C. H. B.	C. H. B.	G. G. W.	G. G. W.	N. B. M.	W. L. M.	W. L. M.
First seen	4-3	9-14	4-17	4-11	4-17	3-27	4-12
Next seen	4-4	.....	4-23	4-12	5-5	4-10	4-16
Common	4-5	.....	4-17	.....	.....	.....	4-28
Last seen	4-21	9-18	4-23	.....	5-5	.....	.....
Abundance	Abundant	Common	Common	.....	.....	Common	Common

180. [675a] *Seiurus noveboracensis notabilis* (Ridgw.). Grinnell's Water-Thrush.

Rare migrant. A specimen taken April 23, 1886, by G. G. Williamson is referred to this form. Probably Grinnell's Water-Thrush will be found to be as numerous as the last when more specimens are obtained for exact identification. The differences are rather slight and more relative than absolute, and as the birds seem to vary considerably, it is no wonder that there has been no distinction made between the two forms in the migration records.

A specimen of this Water-Thrush taken at Indianapolis, May 14, 1875 (D. S. Jordan), shows a variation in a generic character. All parts of definitions of the genus *Seiurus* and of keys referring to the tail feathers are substantially as the following from Ridgway (1902): "Inner webs of lateral rectrices without white terminal spot." The individual under consideration has distinctly marked, white, terminal spots on the first and second outer rectrices of the right side, and slight indications of spots on the two opposite, outermost tail feathers.

181. [676] *Seiurus motacilla* (Vieill.). Louisiana Water-Thrush.

Rather common summer resident. March to September 1.

Song April 12, 1903. May 10, 1903, nest and six eggs, among rocks and roots above the mouth of a cave (C. G. L.). June 3, 1901, nest of leaves, grass-lined, under an overhanging ledge (at the same place). It contained six young (W. L. H.).

All the tangled ravines and cascaded cave outlets ring with the striking song of the Louisiana Water-Thrush in April and early May.

A specimen labeled, Bloomington, March, 1885, Foster Hight, is in the University collection. It has been recorded as early in Indiana at least once before (March 30, '96—Sedan), but such dates are rare.

MIGRATION RECORD.

Year.	1885.	1886.	1901.	1902	1902.	1903.
Observer	C. H. B.	G. G. W. B. W. E. W. S. B.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-18	4-4	4-12	4-13	.....	4-5
Next seen	4-19	4-10	.....	4-20	.....	4-7
Common	4-25	4-27	.....	.....	.....	.....
Last seen	.....	.....	.....	.....	9-1	.....
Abundance	Common.	Common.	.....	Common.	Common.	Common.

182. [677] *Geothlypis formosa* (Wils.). Kentucky Warbler.

Common summer resident. April 13 to August 26.

Song May 3, 1903. "They were found breeding near Bloomington, May 6, 1886 (Evermann), where young were noted just out of the nest, June 4, 1886 (Blatchley)" [A. W. B.].

An inhabitant of dense, moist thickets.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.
Observer	C. H. B.	C. H. B.	B. W. E. W. S. B.	G. G. W.
First seen	.....	5-2	4-17	5-7
Next seen	.....	5-16	4-27	.....
Common	.....	.....	.....	.....
Last seen	8-26	.....	.....	.....
Abundance	Common.	Common.	Common.	.....

Year	1892.	1899.	1902.	1903.
Observer	A. B. U.	N. B. M.	W. L. M.	W. L. M.
First seen	5-7	4-13	4-24	4-28
Next seen	.....	4-15	4-27	5-3
Common	.....	.....	.....	5-13
Last seen	.....	.....	.....	.....
Abundance	.....	Rare.	Common.	.....

183. [678] *Geothlypis agilis* (Wils.). Connecticut Warbler.

Rare migrant (C. H. B., '86—B. W. E., '87). April 27 and May 6, 1886 (B. W. E.). May 18, 1885 (C. H. B.).

184. [679] *Geothlypis philadelphia* (Wils.). Mourning Warbler.

Rare migrant. Seen on the 16th, 17th, and 27th of May, 1885, by C. H. Bollmann.

185. [681] *Geothlypis trichas* (Linn.). Maryland Yellow-throat.

Abundant summer resident. April 20 to October 19.

Song April 28 to September 20, 1903. May 29, 1901, five young with pin-feathers were found in an arched nest in a bunch of dry grass. June 12, 1903, four young about four or five days old were found in a clump of grass about six inches above the ground (C. G. L.).

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	C. H. B.	B. W. E. C. H. B.	G. G. W.	E. M. K.	E. M. K.
First seen	.....	4-20	4-28	4-25	4-25	5-	4-30
Next seen	.....	4-21	4-30	4-28	4-27	.....	.....
Common	.....	5-5	5-5	.....	.....	.....	.....
Last seen	10-17	.....	.....	.....	.....	.....	.....
Abundance	Abundant	Abundant.	Abundant	Abundant.	.....	.....	.....

Year	1899.	1900.	1902.	1902.	1903.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-29	4-24	4-24	.....	4-24	.....
Next seen	.....	5-5	4-25	.....	4-28	.....
Common	.....	.....	5-4	.....	4-28	.....
Last seen	.....	.....	.....	10-19	.....	9-24
Abundance	.....	Common.	Abundant.	Abundant.	Abundant.	Abundant.

186. [683] *Icteria virens* (Linn.). Yellow-breasted Chat.

Abundant summer resident. April 24 to September 28.

Song April 28, 1903. May 17, 1903, a nest and one egg found in a dead bush, which was, however, in a dense clump of living bushes. The nest was found four feet high. It contained four eggs, May 20 (C. G. L.).

MIGRATION RECORD.

Year	1835.	1885.	1886.	1887.	1892	1903.
Observer	C. H. B.	C. H. B.	G. G. W. C. H. B.	G. G. W.	A. B. U. E. M. K.	E. M. K.
First seen		4-25	4-24	4-30	5-4	4-30
Next seen		5-3	4-25		5-7	
Common		5 8			5-13	
Last seen	8-30					
Abundance	Abundant	Abundant	Common.		Common.	

Year	1899.	1901.	1902.	1902.	1903.	1903.
Observer	N. B. M.	W L. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-29	5-4	4-24		4-28	
Next seen		5-7	4-27		4 29	
Common	4-29		5-4		5-3	
Last seen				9-28		9-24
Abundance	Common.	Common.	Abundant	Abundant.	Abundant.	Abundant.

187. [684] *Wilsonia mitrata* (Gmel.). Hooded Warbler.

Rare summer resident. April 20 to September 14.

"At Bloomington, Mr. G. G. Williamson found a nest with six young of this species in a bush, May 27, 1886. It seems to occur there regularly" (A. W. Butler).

No females were seen in 1885 until May 2. The last migrants in the fall of that year were males.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1902.
Observer	C. H. B.	C. H. B.	G. G. W. B. W. E.	G. G. W.	W. L. M.
First seen	4 20	8- 9	5-8	5-7	
Next seen	4-21	9-11	5 26		
Common					
Last seen	5-9	9-14			9 1
Abundance	Rare.	Rare.	Rare.		Rare.

188. [685] *Wilsonia pusilla* (Wils.). Wilson's Warbler.

Rare migrant. May 8-14. August 31 to September 18. The extreme dates are also the limits of its stay in Indiana.

MIGRATION RECORD.

Year	1885.	1885.	1886.
Observer	C. H. B.	C. H. B.	B. W. E.
First seen	5-14	8 31	5-8
Next seen			
Common			
Last seen		9-18	
Abundance	Rare.	Rare.	Rare.

189. [686] *Wilsonia canadensis* (Linn.). Canadian Warbler.

A more common migrant than either of the last two species. April 27 to May 18. August 26 to September 15.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886.
Observer	C. H. B.	C. H. B.	C. H. B.	W. S. B. B. W. E.
First seen	4-28	5 9	8 26	4-27
Next seen	5-8	5 12	8-28	5-4
Common				
Last seen	5-17	5-18	9-15	5-15
Abundance	Common.	Common.	Common.	Common.

190. [687] *Setophaga ruticilla* (Linn.). American Redstart.*

Abundant migrant and common summer resident. April 12 to October 19; the limits of its residence in the State. Scarce in 1885 and 1886 (B. W. E.).

Song April 12, 1903. Nest and three eggs June 12, 1882.

The males arrive about a week in advance of the females. In fall Redstarts are very abundant and are found nearly everywhere.

MIGRATION RECORD.

Year	1885.	1885.	1885.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	C. H. B.	G. G. W. A. W. B.	G. G. W.	A. B. U.
First seen	♂4-21	♂4-30	.....	5-12	4-29	4-30
Next seen	4-22	5-10	.....	5-26	5-1	.....
Common	5-11	5-11	.....	.....	.....	.....
Last seen	.....	.....	10-9	.....	.....	.....
Abundance	Common.	Common.	Common.	.....	.....	.....

Year	1893.	1900.	1902.	1902.	1903.	1903.
Observer	E. M. K.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-6	5-5	4-27	.....	4-12	.....
Next seen	.....	.....	.....	.....	4-13	.....
Common	.....	.....	.....	.....	4-28	.....
Last seen	.....	.....	.....	10-19	.....	9-20
Abundance	.....	.....	Not common	Abundant.	Abundant.	Common.

191. [697] *Anthus pensilvanicus* (Lath.). American Pipit.*

Common migrant (C. H. B., '86). May 17-18—common 19, 1885 (C H. B.). April 1, 1901.

The Pipit probably occurs regularly in considerable numbers, and the above record is imperfect on account of faulty observation.

192 [703] *Mimus polyglottos* (Linn.). Mockingbird.*

Moderately common summer resident.

The Mockingbird was first noted in this locality April 29, 1882, by B. W. Evermann. He says that Bloomington was the farthest north it had been observed in the State at that time. C. H. Bollmann says it was very rare in 1886. He obtained a set of eggs in 1884.

Song April 2, 1903. Two nests were complete April 30, 1901. They were on the northeast pike about one fourth mile apart. The males were singing about these nests both day and night. May 2, 1902, a nest and two eggs were taken from a small thorn bush. The eggs had been broken in some manner (W. L. H.). June 6, 1902, a nest and fresh eggs were found about three feet up in a hedge (C. G. L.).

MIGRATION RECORD.

Year	1882.	1885.	1886.	1893.	1901.	1902.	1903.
Observer	B. W. E.	C. H. B.	G. G. W C. H. B.	E. M. K.	V. H. B. W. L. M	W. L. M.	W. L. M.
First seen	4-29	5-13	5-2	5-15	3-24	3-31	4-2
Next seen	.....	.....	6-1	5-18	4-30	4-27	4-3
Common	.....	.....	.....	.....	.....	5-10	.....
Last seen	.....	.....	.....	.....	.....	.....	.....
Abundance	Rare.	Rare.	Rare.	.....	Common.	Common.	Common.

193. [704] *Galeoscoptes carolinensis* (Linn.). Catbird.*

Abundant summer resident. April 2 to October 6.

Song April 9 to September 20, 1903. Nestbuilding May 3, 1903. Nest and two eggs May 7, 1902 (G. Hitze). On May 12, 1902, five eggs were taken from a nest; a new nest was begun on the next day; the lining was partly made on the 14th and the nest was finished on the 16th. There was one egg on the 17th and four on the 20th. A nest with four fresh eggs was found June 4, 1901 (W. L. H.).

The earliest and latest individuals seen are generally found in the woods in deep-tangled thickets; consequently Catbirds are rarely seen at the extreme dates indicated above.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	W. S. B. C. H. B.	G. G. W.	E. M. K.	E. M. K.
First seen	.....	4-20	4-16	4-25	4-22	4-10
Next seen	.....	4-21	4-17	4-27	4-27	4-17
Common	.....	4-24	.....	.....	4-27	4-20
Last seen	10-6	.....	.....	.....	.....	.....
Abundance	Abundant	Abundant	.....	.....	Common.	Common.

Year	1899.	1900.	1901.	1902.	1903.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-28	4-14	4-28	.....	4-5	.....
Next seen	4-29	4-16	5-3	.....	4-9	.....
Common	4-29	4-20	5-5	.....	4-28	.....
Last seen	.....	.....	.....	10-5	.....	9-20
Abundance	Common.	Common.	Common.	Common.	Abundant	Abundant.

194. [705] *Toxostoma rufum* (Linn.). Brown Thrasher.* Figs. 25-6.

Common summer resident. March 16 to October 12.

Song March 20, 1903. Nest begun April 4, 1903. Nest and four eggs in a berry bush in a corner of a yard, April 20. Young out of nest May 8 (C. G. L.). Four young flying about freely May 13. Nest with 3 eggs as late as June 9, '02 (G. Hitze).

One of our best songsters; most often found just on the outskirts of town.

MIGRATION RECORD.

Year	1884.	1885.	1885.	1896.	1887.	1892.	1893.
Observer	C. H. E.	C. H. B.	C. H. B.	W. S. B. B. W. E. G. G. W.	G. G. W.	E. M. K. A. B. U.	E. M. K.
First seen	3-23	4-4	.....	3-28	4-12	4-2	4-2
Next seen	.....	4-5	.....	4-5	.....	4-9	4-6
Common	.....	4-18	.....	4-14	.....	4-9	4-6
Last seen	.....	.....	10-3	.....	.....	.....	.....
Abundance	.....	Common.	Common.	Common.	.....	Common.	Common.

Year	1899.	1900.	1901.	1902.	1902.	1903.
Observer	N. B. M.	N. B. M.	W. L. M. V. H. B.	W. L. M.	W. L. M.	W. L. M.
First seen	4-16	4-23	4-7	3-16	.....	3-20
Next seen	4-19	.....	4-10	3-24	.....	3-21
Common	4-21	.....	4-14	4-23	.....	4-3
Last seen	.....	.....	.....	.....	10-12	.....
Abundance	Common.	Common.	Common.	Common.	Common.	Common.

195. [718] *Thryothorus ludovicianus* (Lath.). Carolina Wren.*

Common resident. Sings at all times in the year. The Carolina Wren became common here about 1883 (B. W. E.). "It was heard nearly every day that winter."

An inhabitant of dense thickets and brush-piles. Not often seen away from these places except when singing. Ordinarily a very hard bird to flush. Several times the writer has cornered a Carolina Wren in a brush-pile, and walked up to the edge of it without the bird leaving. Once, even, I walked over a brush-heap with a wren in it and the bird left only when the heap was torn to pieces. (March 3, '01). Another instance of this habit is as follows: On a cold, snowy, windy day, I was investigating the base of a hollow tree. After rummaging around on the inside for three or four minutes, I touched a Carolina Wren which then flew hastily out (February 2, '02).

196. [719] *Thryomanes bewickii* (Aud.). Bewick's Wren.*

Very common summer resident. March 6 to October 12. Bewick's Wren was taken in this county as early as 1876 (Ind. Univ. Mus.). It was a common summer resident ten years later, and now is very common and almost entirely replaces the next species (*T. aëdon*) which is a rather rare bird.

Song March 13, 1903; breeding March 25, 1901. Nest and eight eggs in an old sack hung over a fence, April 14, 1903 (C. G. L.).

Most frequently found near houses; common in the city; a persistent songster in March and April.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1893.
Observer	C. H. B.	C. H. B.	G. G. W. W. S. B.	G. G. W.	E. M. K.
First seen	4-5	.....	3-26	4-2	3-20
Next seen	4-7	.....	4-8	4-13	.....
Common	4-18	.....	.....	.....	.....
Last seen	.....	9-27	.....	.....	.....
Abundance	Common.	Not common	Common.	Common.	.....

Year	1899.	1900.	1901.	1902.	1903.
Observer	N. B. M.	N. B. M.	W. L. M.	W. L. M.	P. J. H. W. L. M.
First seen	4-13	4-2	3-25	.....	3-6
Next seen	4-14	4-7	3-26	.....	3-8
Common	4-21	4-15	.....	.....	3-21
Last seen	.....	.....	.....	10-12	.....
Abundance	Common.	Common.	Common.	Common.	Common.

197. [721.] *Troglodytes aëdon* Vieill. House Wren.* Fig. 9.

Rather rare summer resident. March 9 to September 16. The House Wren was a rare summer resident and less common than *T. bewickii* in 1887 (B. W. E.).

A nest of the House Wren was found April 25, 1903, in a tin can sitting on a fence. The nest was just completed and contained no eggs (C. G. L.). May 21, 1902, seven well-feathered young were found; two days later these had flown (G. Hitze).

The dates for 1901 would probably be more correctly attributed to *T. bewickii*. The song was heard that year on February 21 (V. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.
Observer	C. H. B.	C. H. B.	G. G. W.	G. G. W.
First seen	4-19	.....	5-1	4-30
Next seen	4-20	.....	5-14	.....
Common	5-6	.....	.....	.....
Last seen	.....	9-16	.....	.....
Abundance	Common.	Not common	.....	Not common

Year	1892.	1901.	1903.
Observer	A. B. U. E. M. K.	V. H. B.	W. L. M.
First seen	3-27	2-11	3-9
Next seen	3-31	2-13	4-29
Common	.....	3-18	.....
Last seen	.....	.....	.....
Abundance	.....	Common.	Rare.

198. [722] *Olbiorchilus hiemalis* (Vieill.). **Winter Wren.***

Rare in winter; more common during the migrations. October 4 to May 3. Absent during the winter 1902-3.

Most of the individuals departed April 19, 1885 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1900.	1901.	1903.
Observer	C. H. B.	C. H. B.	G. G. W.	G. G. W.	N. B. M.	V. H. B.	W. L. M.
First seen		10-4					
Next seen		10-9					
Common	4-4						
Last seen	5-3		4-24	4-20	4-17	3-3	4-30
Abundance	Not common	Common	Not common	Not common			Rare.

199. [725] *Telmatodytes palustris* (Wils.). **Long-billed Marsh Wren.**

Rare migrant. May 10, 1886 (C. H. B.—G. G. W.); May 13 (B. W. E.); September 29, 1903, common.

200. [726] *Certhia familiaris americana* (Bonap.) **Brown Creeper.***

Rare in winter, common in spring and fall (C. H. B., '86). September 27 to May 30.

In April this bird may generally be found wherever there are Kinglets.

Most of them departed April 20, 1885 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1888.	1899.
Observer	C. H. B.	C. H. B.	G. G. W.	G. G. W.	G. G. W.	
First seen	4-1	9-27	4-13	4-9		
Next seen	4-2	10-4	4-18	4-11		
Common	4-4					
Last seen	4-25				5-30	4-10
Abundance	Common.	Common.	Common.	Common.		Rare.

Year	1900.	1901.	1902.	1902.	1903.	1892.
Observer	N. B. M.	V. H. B.	W. L. M.	W. L. M.	W. L. M.	E. M. K.
First seen	4-8	3-9	3-12	11-18	1-17	.....
Next seen	4-12	3-18	3-27	.....	1-18	.....
Common	.....	.....	4-13	.....	.....	.....
Last seen	4-17	.....	4-19	12-14	4-12	4-7
Abundance	Not common	.....	Common.	Common.	Common.	Common.

201. [727] *Sitta carolinensis* Lath. **White-breasted Nuthatch.***

Common resident. Attempts at song March 8, 1902; five days earlier they were seen going in and coming out of a cavity in a tree, which they afterwards used as a nest.

202. [728] *Sitta canadensis* Linn. **Red-breasted Nuthatch.***

Common migrant and rare winter resident. September 20 to May 12. "They were found wintering at Bloomington the winters of 1882-3 and 1885-6" (Blatchley). Also winters of 1884-5; 1902-3.

MIGRATION RECORD.

Year	1883.	1885.	1885.	1886.	1886.	1887.
Observer	B. W. E.	C. H. B.	W. S. B. C. H. B.	B. W. E. W. S. B.	W. S. B.	G. G. W.
First seen	2-10	1-31	10-2	2-22	.....	.....
Next seen	.....	2-2	10-7	2-23	.....	.....
Common	.....	.....	.....	.....	.....	.....
Last seen	.....	5-12	11-25	4-24	12-21	5-7
Abundance	Rare.	Not Common.	Not Common.	Not Common.	Common.	.....

Year	1901.	1902.	1902.	1903.	1903.
Observer	V. H. B.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	.....	2-28	10-12	1-14	9-20
Next seen	.....	3-10	10-26	1-18	9-24
Common	.....	.....	.....	4-29	9-25
Last seen	4-7	4-24	11-30	5-2	.....
Abundance	.....	Rare.	Rare.	Common.	Common.

203. [731] *Bæolophus bicolor* (Linn.). Tufted Titmouse.*

Abundant resident. Nestbuilding April 12, 1903; May 7, 1901.

An ubiquitous species with a great variety of calls and songs.

204. [735] *Parus atricapillus* Linn. Chickadee.*

Seen here only as a winter visitor. November 7 to May 15. It is probably not a common winter resident, though so reported by C. H. Bollman ('86). W. S. Blatchley says it was as common a winter resident, and B. W. Evermann says it was as common a resident as *P. carolinensis* in 1886. N. B. Myers says a few breed, but most of them go north. The latter records are probably due to confusion with the next species. All the specimens in the University collection have been examined and only one from this locality that was labeled *P. atricapillus* was identified correctly. There are, however, several unlabeled ones which come under this species. Its true status is that of an uncommon winter visitor.

MIGRATION RECORD.

Year	1884.*	1885.	1886.	1892.	1895.	1899.	1900.
Observer	C. H. E.	C. H. B.	W. S. B.	A. B. U.	L. Hughes.	N. B. M.	N. B. M.
First seen					11-7		
Next seen							
Common		3-26					
Last seen	3-3	4-16	5-15	2-13		5-2	4-28
Abundance		Common.					

205. [736] *Parus carolinensis* Aud. Carolina Chickadee.*

Common resident. Seen more often and in greater numbers after March 8, 1903; February 18, 1902; April 30, 1885 (C. H. B.).

Song January 18 to November 28, 1902. Mating March 15, 1902; nestbuilding April 14, 1901. May 29, 1901, four young with pin-feathers and one egg were found in a nest about three feet from the ground in a willow stub. The nest was about three inches in depth and was lined with rabbit fur and other soft materials. The young were not yet able to sit on a perch, June 3 (W. L. H.).

206. [748] *Regulus satrapa* Licht. Golden-crowned Kinglet.*

Abundant migrant and rare winter resident. February 4 to May 7. September 21 to November 28. "They are reported as winter residents from Bloomington (Evermann, Blatchley). Also by G. G. Williamson.

Song heard April 16, 1902. This bird has a surprisingly loud, sharp whistle, with a somewhat ventriloquial effect.

On April 6, 1902, a Golden-crowned Kinglet was observed to catch a moth of apparently half its own size. It took several minutes time and much trouble to finish the insect and it was dropped once but was recovered and finally disposed of.

MIGRATION RECORD.

Year	1884.	1885.	1885.	1886.	1887.	1892.	1893.	1895.
Observer	B. W. E.	C. H. B.	C. H. B.	G. G. W.	G. G. W.	E. M. K.	E. M. K.	L. Hughes.
First seen	2-10	.....	10-3	3-19	.....	4-4	2-4	.....
Next seen	.....	.....	10-5	.....	.....	4-9	2-11	.....
Common	.....	4-2	10-9	4-13	.....	4-9	.....	.....
Last seen	.....	4-19	10-25	4-13	5-7	4-24	.....	11-7
Abundance	Rare.	Abundant	Abundant	.....	.....	Common	Common	.....

Year	1899.	1900.	1901.	1902.	1902.	1903.	1903.
Observer	N. B. M.	N. B. M.	W. L. M. V. H. B.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	4-10	4-4	3-20	3-27	10-5	3-18	9-21
Next seen	4-13	4-6	3-22	3-28	10-16	3-19	9-22
Common	.....	.....	4-5	4-15	10-18	3-23	9-21
Last seen	.....	4-12	4-21	4-23	11-28	4-19	.....
Abundance	.....	.....	Abundant.	Common	Common	Abundant.	Abundant.

207. [749] *Regulus calendula* (Linn.). Ruby-crowned Kinglet.*

Abundant migrant and rare winter resident. March 23 to May 18. September 21 to October 24. "They have been noted, in winter, in Monroe County, by Profs. Evermann and Blatchley." (A. W. Butler.)

Song April 5, 1901; 10, 1903. Mating April 19 and 24, 1903. April 10, 1903. Heard a Ruby-crowned Kinglet singing a varied and pretty song which was so loud that it did not seem possible that so small a bird could produce it. The Ruby-crown also gave a little *chuck*, a short whistle, and another note like that of a Canada Nuthatch, but less complaining. The last note was repeated several times. On April 19, two Ruby-crowns were seen, one of which with crown erected and singing, was chasing the other. Was this not mating? On the 24th two other in-

dividuals were seen doing the same thing, and another was heard singing. The song reminds one of nothing more plainly, than of the softer, less ambitious efforts of a canary. It is varied with little chirps and *chuck* and *chirr* notes.

The bulk left May 2, 1885 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	C. H. B. G. G. W.	G. G. W.	E. M. K.	E. M. K.
First seen	4-18	9-28	4-19	4-10	4-9	4-19
Next seen	4-19	10-3	4-22	4-11	4-23	.....
Common	4-22	19-8	.....	.....	4-27	.....
Last seen	5-11	10-24	4-24	.....	5-18	.....
Abundance	Abundant.	Abundant.	Common.	.....	Not common	.....

Year	1901.	1902.	1902.	1903	1903.
Observer	W. L. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	3-29	4-6	10-2	3-23	9-21
Next seen	.....	4-11	10-4	3-25	9-22
Common	.....	4-13	10-2	3-23	9-21
Last seen	4-5	4-27	10-15	4-30	.....
Abundance	Common.	Common.	Common.	Abundant.	.....

208. [751] *Polioptila caerulea* (Linn.). Blue-gray Gnatcatcher.* **Figs. 27–8.**

Common summer resident. April 5 to September 12.

Song and mating April 12, 1903. A nest containing one egg of a Cowbird was found April 22, 1886 (B. W. E.). This was ten days after their arrival. Three days after they arrived in 1902 Gnatcatchers were seen nestbuilding (April 24); the nest was half-finished on the 27th. In 1903 no completed nest was found until the 27th of April, which was 20 days after their arrival. On May 26, 1903, a nest and four well-incubated eggs were found. The nest was saddled on a limb of a small elm, about fourteen feet from the ground (C. G. L.). W. S. Blatchley (1888), in "The Audubon Magazine," describes a two-story nest of the Blue-gray Gnatcatcher, taken near Bloomington. A Cowbird had deposited an egg

in the nest proper and the second story was built over this egg (A. W. Butler).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	B. W. E.	G. G. W.	A. B. U. E. M. K.
First seen	4-5	.....	4-12	4-11	4-17
Next seen	4-6	.....	4-13	.....	4-23
Common	4-17	.....	.....	.....	.....
Last seen	.....	9-12	.....	.....	.....
Abundance	Common	Common.	Common.	.....	.....

Year	1893.	1899.	1901.	1902.	1903.
Observer	E. M. K.	N. B. M.	W. L. M. C. H. E.	W. L. M.	W. L. M.
First seen	4-6	4-13	4-29	4-15	4-7
Next seen	5-4	4-15	5-1	4-19	4-11
Common	.....	.....	.....	4-19	4-12
Last seen	.....	.....	.....	.....	.....
Abundance	.....	.....	.....	Common.	Common.

209. [755] *Hylocichla mustelina* (Gmel.). Wood Thrush.*

Common summer resident. April 12 to October 12.

Song May 4, 1904 (F. E. L.). Nest and eggs May 6, 1886 (B. W. E.).

A resident of the deeper woods. There his fine song may be heard at its best in early May.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.
Observer	C. H. B.	C. H. B.	W. S. B. C. H. B. G. G. W.	G. G. W.	A. B. U.
First seen	4-20	.....	4-17	4-25	5-7
Next seen	4-21	.....	4-22	.....	.....
Common	4-28	.....	4-24	.....	.....
Last seen	.....	9-19	.....	.....	.....
Abundance	Abundant.	Abundant.	Abundant.	.....	.....

Year	1900.	1901.	1902.	1902.	1903.
Observer	N. B. M.	W. L. M.	W. L. M.	W. L. M.	W. L. M.
First seen	5-2	5-6	4-24	.....	4-12
Next seen	5-4	.....	4-25	.....	4-17
Common	5-9	.....	.....	.....	5-5
Last seen	.....	.....	.....	10-12	.....
Abundance	Common.	.....	Moderat'ly Common.	Moderat'ly Common.	Common.

210. [756] *Hylocichla fuscescens* (Steph.). Wilson's Thrush.

Rather rare migrant. April 23 to May 16. September 1 to 13. Apparently common in 1885 (C. H. B.) now the rarest of the Thrushes.

Most of the birds departed May 10, 1885 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1883.	1902.	1903.
Observer	C. H. B.	C. H. B.	C. H. B.	W. L. M.	W. L. M.
First seen	4-23	9-1	.....	5-4	4-26
Next seen	4-26	9-8	.....	.....	.....
Common	5-4	.....	.....	.....	.....
Last seen	5-16	9-13	5-13	.....	.....
Abundance	Common.	Common.	Common.	Rare.	Rare.

211. [757] *Hylocichla aliciæ* (Baird). Gray-cheeked Thrush.

Rather uncommon migrant. April 10 to May 17. September 2 to 25. Formerly much more common; abundant in 1885 (C. H. B.).

Some question has been raised about the validity of the records of early arrival of the present species in the central states. The dates recorded are earlier than those noted for the arrival of the species on the southern coast of the United States. If these records are proved to be correct, they will establish what is at least not a common phenomenon of migration a journey from Central America, at least, across the Gulf and half across the continent before a stop is made. The very number of these early records from different points and by different observers in Indiana, is almost sufficient proof of their reliability. Some of these records are: Spearsville, April 14 and 15, 1894; April 3 to 10, 1895 (V. H. Barnett); Laporte, April 10 to 12, 1892 (Charles Barber); Brown County,

April 14, 1894 (E. M. Kindle) and Bloomington, April 10, 1903 (W. L. M.). It is claimed that the more usual and expected occurrence would be the arrival of this species at about the time of arrival of Wilson's and the Olive-backed Thrushes. Further observation and especially collection of specimens is needed to settle the question. The Gray-cheeked Thrush is only rarely recorded as late as early October, as are also the Veery and Swainson's Thrushes. But a specimen is recorded in the catalogue of the Indiana University Museum, taken by David Starr Jordan, November 1, 1875, at Indianapolis.

MIGRATION RECORD.

Year	1885.	1885.	1886.	1903.
Observer	C. H. B.	C. H. B.	G. G. W. W. S. B.	W. L. M.
First seen	4-22	9-2	5-1	4-10
Next seen	4-25	9-4	5-17	4-20
Common	5-3	9-5	.....	.....
Last seen	5-17	9-25	.....	.....
Abundance	Abuudant.	Abundant.	.....	Rather rare.

212. [758a] *Hylocichla ustulatus swainsonii* (Cab.). Olive-backed Thrush.

Rather rare migrant. April 28 to May 19. September 1 to October 2. C. H. Bollmann considered this species an abundant migrant in 1885. At present only a few are seen each year.

Most of the individuals departed May 17, 1885 (C. H. B.). Perhaps the reduction in numbers of all the less hardy, wood-loving thrushes, in recent years is due to the cutting away of timber in this region. There are very few of those cool, dark, virgin forests, which are said to be the favorite haunts of our wood thrushes, remaining in this region at present.

MIGRATION RECORD.

Year	1885.	1885.	1887.	1892.	1903.
Observer	C. H. B.	C. H. B.	G. G. W.	A. B. U. E. M. K.	W. L. M.
First seen	5-2	9-1	4-28	5-9	4-29
Next seen	5-3	9-6	.....	5-14	4-30
Common	5-10	9-18	.....	.....	.....
Last seen	5-19	10-2	.....	5-15	.....
Abundance	Abundant.	Abundant.	.....	.....	Rare.

213. [759b] *Hylocichla guttata pallasii* (Cab.). Hermit Thrush.

Common migrant March 23 to May 3. October 3 to November 21. The extreme dates mark the limits of its stay in the State, unless it has recently been found to winter in the lower Wabash Valley.

The most common of the Thrushes in the migratory season. Found in second-growth and open woods.

The majority left April 25, 1885 (C. H. B.).

MIGRATION RECORD.

Year	1885.	1885.	1886.	1887.	1892.	1893.
Observer	C. H. B.	C. H. B.	W. S. B.	G. G. W.	E. M. K. A. B. U.	E. M. K.
First seen	3-31	10-3	4-17	4-12	4-2	4-19
Next seen	4-1	10-4			4-9	4-27
Common	4-19	10-10				
Last seen	4-28	10-25			4-23	
Abundance	Common.	Common.			Common.	Common.

Year	1900.	1901.	1902.	1903.	1903.
Observer	N. B. M.	C. H. E.	W. L. M.	W. L. M.	W. L. M.
First seen	4-9	4-29	3-23	4-5	
Next seen			3-25	4-7	
Common				4-12	
Last seen			3-27	5-3	11-21
Abundance	Not common		Common.	Common.	Common.

214. [761] *Merula migratoria* (Linn). American Robin.* Fig. 30.

Resident: abundant in all seasons except winter when it is generally rather rare. However, on January 30, 1893, a winter day, 300 Robins were seen by E. M. Kindle. This was probably a band of migrants, and its occurrence then was not unusual. They become common from the middle of February to the middle of March. Some winters they are entirely absent—that of 1900-01 for instance. They have been observed in flocks here as late as April 13, 1903. There is generally a period in fall

when Robins are scarce, followed by a period of abundance before the numbers dwindle down to the usual winter representation. This is caused in all probability by the summer residents of more northern regions, halting here in what to them is a mild climate, after our own summer birds have departed. A similar movement is noticeable among the Bluebirds. The condition of mid-autumn abundance occurred October 22, 1902. Three days later these birds became rarer and flocks were seen migrating at a considerable elevation by day.

Singing began very early in 1903. One was heard singing his spring song, very low as if in rehearsal, January 16, and one burst out in full song January 20. The next song was heard February 24. In other years I have heard an imperfect song as early as February 23, and the complete song March 4, 1902. They continue their songs till late in the year. Perfect songs are heard in August, and on September 1, 1902, a Robin was heard singing with all the vigor if not the perfection of spring. Songs, perhaps slightly imperfect, but not very noticeably so, have been heard as late as October 26, 1902.

They have been observed mated by February 26, 1903. The first nest has been completed as early as March 21, 1903 (P. J. H.). Very little mud was used in the construction of this nest. That this was early in the season as well as in the calendar may be judged by the fact that an inch of snow fell shortly afterwards. The first egg was found March 29, 1903. It was in a nest in a beech tree. The nest was within ten feet of a window in Science Hall (C. G. L.). A full set was not found until April 8, but on April 26 two half-grown young, not accompanied by their parents, were observed. On May 3 two young nearly full grown were seen. Twenty-four days (April 23 to May 17) elapsed between the laying of the third egg and the flight of the young in a nest watched in 1892 (G. Hitze).

One was noticed before daybreak on March 26, 1903, sitting on the ground and singing vigorously. It was observed in the same place the next morning.

When the country is snowbound Robins resort to peculiar methods to obtain a livelihood; one was seen wading about in a shallow spring-fed stream, feeding in the manner of a Sandpiper, February 9, 1902.

MIGRATION RECORD.

Year	1883.	1884.	1885.	1886.	1887.	1892.
Observer	B. W. E.	C. H. E.	C. H. B.	B. W. E. G. G. W.	G. G. W.	E. M. K.
First seen	2-10	2-9	2-14	2-13	1-16	2-1
Next seen	2-13	.....	3-3	2-20	1-17	2-6
Common	2-13	.....	3-7	2-23	2-7	2-6
Last seen	.....	.....	.....	.....	.....	.....
Abundance	Abundant.	.....	Abundant.	Common.	.....	Common.

Year	1893.	1899.	1900.	1901.	1902.	1903.
Observer	E. M. K.	N. B. M.	N. B. M.	V. H. B. W. L. M.	W. L. M.	W. L. M.
First seen	1-28	2-12	2-20	2-19	.....	.....
Next seen	1-29	2-19	3-3	2-27	.....	.....
Common	2-13	3-16	3-9	3-3	3-1	2-27
Last seen	.....	.....	.....	.....	.....	.....
Abundance	Common.	Common.	Common.	Common.	Abundant.	Abundant.

215. [766] *Sialia sialis* (Linn.). Bluebird.* Figs. 31-2.

Resident; abundant in all seasons except winter, moderately common then. Becomes abundant before the middle of March (February 22 to March 16). Seen in pairs February 22, 1884 (C. H. E.). All records of Bluebirds for the winters 1900-01 and 1901-2 were made by groups and show just how the birds were met. Nearly all of these groups are twos or multiples of two, and of them equal numbers were male and female. This is pretty good evidence that many Bluebirds remain paired throughout the year. However, some of the summer residents mate here, and they were seen mating March 1, 1903. Two males were singing madly and flying excitedly about a female, the principal characteristic of whose attitude seemed to be utter indifference to both of her suitors.

Singing February 10, 1903. The first nest was finished March 15, 1903; it was in a fencepost which had rotted in two just above the ground and which swayed on its supporting wires, with every wind. A nest with three eggs was found March 22; and one with four eggs

April 2. On April 4 a nest and six eggs were found in an old Woodpecker's hole (C. G. L.). On April 27, four young Bluebirds 3-4 days old were found and on the 29th seven young, fully feathered and about four inches long, were seen flying about freely with their parents.

On November 30, 1902, Bluebirds were acting as Phœbes are often seen to do; they used a perch near the ground from which they suddenly flew down, picked up an insect or other morsel of food, always returning to the same perch.

MIGRATION RECORD.

Year	1883.	1884.	1885.	1886.	1887.
Observer	B. W. E.	C. H. E.	C. H. B.	B. W. E.	B. W. E.
First seen	1-12	2-2	.....	2-20	1-1
Next seen	.....	2-9	.....	2-21	1-3
Common	.....	2-22	2-28	2-22	.....
Last seen	.....	.....	.....	.....	.....
Abundance	Abundant.	Common.	.....	Common.	.....

Year	1892.	1900.	1901.	1902.	1903.
Observer	A. B. W.	N. B. M.	W. L. M.	W. L. M.	W. L. M.
First seen	1-28	2-19	2-10	.....	.....
Next seen	2-6	2-22	2-17	.....	.....
Common	.....	.....	3-2	3-16	3-8
Last seen	.....	.....	.....	.....	.....
Abundance	Common.	Rare.	Common.	Abundant.	Abundant.

SUPPLEMENTAL LIST.

1. [51] *Larus argentatus* (Brünn). Herring Gull.

Very probably seen by J. J. Batchelor, April, 1902. See note under *L. philadelphia* in main list.

2. [208] *Rallus elegans* Aud. King Rail.

Rare migrant in Brown County (E. M. K. '94). Will probably be found to have the same rank in avifauna of this county.

3. [226] *Himantopus mexicanus* (Müll.). Black-necked Stilt.

C. H. Bollmann gives a queried record for Monroe County in his list of 1886, and ranks it as rare. It has not otherwise been recorded in the State.

4. [305] *Tympanuchus americanus* (Reich.). Prairie Hen.

Given in C. H. Bollmann's list of 1886 as one of the birds which had to his knowledge been found in the county but which had disappeared.

5. [310] *Meleagris gallopavo merriami* Nelson. Wild Turkey.

A rare resident as late as 1886 (C. H. B.), when a few were seen each year (W. S. B.). In 1887 B. W. Evermann said that although he had not observed it, it was still occasionally taken. In 1894 E. M. Kindle wrote that it was almost if not entirely extinct in Brown County. The Wild Turkey is without doubt entirely extinct in this county.

6. [315] *Ectopistes migratorius* (Linn.). Passenger Pigeon.

A rare migrant in 1886 (C. H. B.). B. W. Evermann in 1887 classed it as formerly abundant but then rare. The last date at hand for this county is April 18, 1885, when ten were seen by C. H. Bollmann. It has been observed since that time in Brown County March 7, 1894 (E. M. K.); 60 were seen April 12, 1895 (V. H. B.).

7. [382] *Conurus carolinensis* (Linn.). Carolina Paroquet.

Given the same position by C. H. Bollmann in his list of 1886 as the Prairie Hen. (See above.) "Judge A. L. Roach of Indianapolis says Parakeets were common in Monroe County in 1828 when his father's family moved there. The family came from western Tennessee, where the bird was abundant and well known. He says they were still there

in 1836. * * * B. W. Evermann learned from the late Louis Bollmann that they were there in 1831. * * * W. B. Seward of Bloomington said that these birds were well known to him from 1840-1850 and were in many places common" (A. W. Butler in "The Auk," Vol. IX. pp. 49-56). "Mr. W. B. Seward informs me of obtaining some five, he thinks, young Paroquets from a farmer's boy in Owen County (adjoining Monroe) in 1845. His impression is they were taken from the inside of a hollow tree, on the borders of White River. This is the farthest north we have any account of their nesting" (Butler, Birds of Indiana, 1897). In Brown County it was formerly abundant along Bean Blossom Creek (E. M. K.).

8. [392] *Campephilus principalis* (Linn.). Ivory-billed Woodpecker.

"Formerly common, now rare" (B. W. E. '87). Recorded by C. H. it was formerly found in Monroe County" (Butler).

9. [486] *Corvus corax sinuatus* (Wagl.). American Raven.

"Formerly common, now rare" (B. W. E. '87). Recorded by C. H. Bollmann ('86) along with the Prairie Hen and Parakeet as one of the birds which had formerly been found in the county, but which was then extinct.

ADDENDA.

30.5. [212.] *Rallus virginianus* (Linn.). Virginia Rail.

Uncommon migrant. Several were seen and one killed with a club in a yard in town, April 22, 1904.

No. 1. Nest and eggs of Little Green Heron in an apple tree.

No. 2. Same nest, with four young and two eggs yet unhatched.

No. 3. Four young of Little Green Heron posing for the camera.

No. 4. Cut of two young Herons, showing the tenacity with which they cling to a stick.

No. 5. Two young Little Green Herons posing.

No. 6. Nest of Killdeer on ground.

No. 7. Nest and eggs of Dove on rail fence. Nest is simply a slight addition to old nest of some other bird.

No. 8. Eggs of Dove on ground. No nest whatever.

No. 9. Nest and eggs of Dove on stump.

No. 10. Nest and eggs of Dove in cedar.

No. 11. Nest and three eggs of Black-billed Cuckoo.

No. 12. Nest and six eggs of Downy Woodpecker in fence post.

No. 13. Nest and five eggs of Flicker in apple tree.

No. 14. Nest and eggs of Kingbird in apple tree.

No. 15. Nest and six eggs of Phœbe on stone abutment of a bridge.

No. 16. Nest and five eggs of Jaybird in apple tree.

No. 17. Nest of Meadowlark, opened somewhat to show eggs.

No. 18. Nest and three eggs of Chipping Sparrow, with one Cowbird egg, placed in a pear tree.

No. 19. Nest and three eggs of Field Sparrow.

No. 20. Nest and four eggs of Song Sparrow.

No. 21. Nest and eggs of Chewink. Two of the eggs do not show on account of position of camera.

No. 22. Nest and three eggs of Cardinal in cedar tree.

No. 23. Nest and three eggs of Blue-headed Vireo, with Cowbird egg.

No. 24. Nest and one egg of White-eyed Vireo, with two Cowbird eggs.

No. 25. Nest and four eggs of Brown Thrasher.

No. 26. Nest and four eggs of Brown Thrasher on ground.

No. 27. Nest and four eggs of Blue-gray Gnatcatcher in elm tree.

No. 28. Side view of nest of Blue-gray Gnatcatcher.

No. 29. Nest and six eggs of House Wren in sack hanging on fence. Hole in sack was enlarged to show nest.

No. 30. Nest and eggs of Robin on rail fence. Only one egg shows on account of position of camera.

No. 31. Nest and five eggs of Bluebird.

No. 32. Young of Bluebird.

TABLE.*

This table summarizes the facts recorded in the body of the paper. By means of table it will be easy for anyone to tell at a glance what birds may be expected during any week of the year, and the position of any bird in relation to the entire Calendar. When a bird has only been taken during one or two years this fact is indicated by the date; thus, under 7, the Cormorant has only been recorded in May 8, 1885. The abbreviations a=abundant; r=rare; w=winter; c=common; n=nest with eggs or young, are used and are self explanatory.

	Permanent Resident.	Winter Resident.	Summer Resident.	Regular Migrant.	Occasional Visitor or Migrant.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. Horned Grebe				×					11-24								
2. Pied-billed Grebe				×				8-	-29						7-	-30	
3. Loon				×					1-	-11							
4. Bonaparte's Gull					×				1903 16								
5. Forster's Tern					×					1903 13							
6. Common Tern					1886 ×												
7. Double-crested Cormorant					1885 1886 ×					1885 3							
8. American Merganser				×					16-	-14							
9. Hooded Merganser				×				4									
10. Mallard				×a			10-	—	-23								
11. Green-winged Teal				×				4-	-17								
12. Shoveller				×				20-	—	-8							
13. Pintail				×			26-	4									
14. Wood Duck			?	×				24	—	?	?	?	?	?			
15. Redhead					1903 ×			20									
16. Canvas-back				×					23								
17. American Scaup Duck					×			4									
18. Lesser Scaup Duck				×				9-	—	-8							
19. American Golden-eye				×				1									

20. **Buffle-head**					1886 1887 ×			5										
21. **Surf Scoter**					1886 ×													
22. **Ruddy Duck**					×				1903 24									
23. **Blue Goose**					1886 ×													
24. Canada Goose				×			17–	—	–12						31–	–24		
25. American Bittern				×r					5–	–13			27–	—	–22			
26. **Least Bittern**					1902 ×													
27. **Great Blue Heron**				×r				12–	–30				25					
28. American Egret					1887 ×				10			29						
29. Green Heron			✓						10–	—	—	—	—	–22				
30. Whooping Crane					×													
31. Sora					×				15–	–8			×					
32. **Yellow Rail**					1885 1887 ×													
33. **Florida Gallinule**					×					1880 10								
34. American Coot					×				12–26									
35. **Am. Woodcock**			1886 ×		×	×		4–	–19									
36. Wilson's Snipe				✓				6–	—	10				22–	–28			
37. Pectoral Sandpiper				×				15–	—	–9								
38. **Least Sandpiper**					1887 ×													
39. Semipalmated Sandpiper					×				26–	–3								
40. Greater Yellow-legs					×				26–	–1								
41. Y llow Legs.					×				1895 26									
42. Solitary Sandpiper			×r	×					23	—	–9				6			
43. **Bartramian Sandpiper**					1886 ×													
44. Spotted Sandpiper			×r	×					12	–7	?	?	?					
45. Killdeer		×r	×r			31–	—	—	n	n	—	—	—	—	—	—	r–12	
46. Bob-white	✓					—	—	—	—	—	—	—	—	—	—	—	—	
47. Ruffed Grouse	×r							14–23	7					23				
48. Mourning Dove		×r	×			?	?	8n	n	n	n	n	n	n	—	–9	?	
49. Turkey Vulture	×	×r				31–	—	—	—	n	—	—	—	—	—	a–21		
50. Black Vulture					×					1903 16								
51. **Swallow-tailed Kite**					×								1885 4, 18					

TABLE—Continued.

	Permanent Resident.	Winter Resident.	Summer Resident.	Regular Migrant.	Occasional Visitor or Migrant.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
52. Marsh Hawk				×r			28-	—	-19								
53. Sharp-shinned Hawk	×r					—	—	—	?	?	?	?	?	?	—	—	—
54. Cooper's Hawk	✓					a	—	a	r	—	—	—	—	—	—	—	r
55. American Goshawk					×											1885 22	
56. Red-tailed Hawk	×					—	—	—	n19	—	—	—	—	—	—	—	—
57. Red-shouldered Hawk	×					—	—	—	—	—	—	—	—	—	—	—	—
58. Broad-winged Hawk	×r					—	—	—	a	—	—	—	—	—	a	—	—
59. Am. Rough-legged Hawk					×		1885 21										
60. Golden Eagle		×r				—	—	—	—	15		1885 29				28	—
61. Bald Eagle					×												
62. Pigeon Hawk					×			12-	-28							7	
63. American Sparrow Hawk	×					—	—	n	n	—	—	—	—	—	—	—	—
64. American Osprey				×r				12-	-29								
65. American Long-eared Owl					×	1883 30		1885 19									
66. Short-eared Owl						1886 ×											
67. Barred Owl	×					?	?	1902 24	?	?	?	?	?	?	?	?	?
68. Saw-whet Owl	×r					?	?	?	?	?	?	?	?	1884 20	?	1886 27	
69. Screech Owl	×					—	—	—	—	—	—	—	—	—	—	—	—
70. Great Horned Owl	×					?	?	1903 22	?	?	?	?	?	?	?	?	?
71. Snowy Owl					×	1903 25											
72. Yellow-billed Cuckoo			×						13-	n	n	—	—	-24			
73. Black-billed Cuckoo			×						13-	n	—	—	—	-22			
74. Belted Kingfisher		×r	×			1893 4		5-	—	—	—	—	—	—	—	-9	
75. Hairy Woodpecker	×					—	—	—	—	—	—	—	—	—	—	—	—
76. Downy Woodpecker	×					—	—	—	n	n	—	—	—	—	—	—	—

77.	Yellow-bellied Woodpecker	.....	×r	.....	×	.....	1903 21	—	—	—	-5	.....	...	.....	15-	—	—	-29
78.	Northern Pileated Wood'ker	×r	.....	.....	.....	.....	r	r	r	r	r	r	r	r	r	r	r	r
79.	Red-headed Woodpecker	×	.....	.....	.....	.....	r	r	r	a	a	a	a	a	a	a	a	r
80.	Red-bellied Woodpecker	×	..	.....	.....	.....	r	r	a	a	a	a	a	a	a	a	a	r
81.	Northern Flicker	×	..	.....	.....	.....	—	—	—	a	—	—	—	—	—	—	—	—
82.	Whip-poor-will	.....	..	×	.....	.....	.....	.....	.....	21-	—	—	—	—	?	?	?	.....
83.	Night Hawk	.....	.....	×	.....	.....	.....	.....	.....	28-	—	—	—	—	-21	.....	.....	.....
84.	Chimney Swift	.....	..	×a	.....	.....	.....	.....	.....	4-a	a	a	—	—	—	-14	.....	.....
85.	Ruby-throated Hummingbird	.....	.....	×	.....	.....	.....	.....	.....	29-	a	—	—	—	-26	.....	.....	.....
86.	Kingbird	.....	.....	×	.....	.....	.....	.....	.....	14-	a	a	—	—	-15	.....	.....	.....
87.	Crested Flycatcher	.....	.....	×	.....	.....	.....	.....	.....	18-	a	a	—	—	-7	.....	.....	.....
88.	Phœbe	.....	.....	×	.....	.....	.....	.....	1-n	a	—	—	—	—	—	-17	.....	.....
89.	Olive-sided Flycatcher	.....	.....	.....	.....	×	.....	.....	.....	1885 30	1885 12	.....	.....	.....	.....	.....	.....	.....
90.	Wood Pewee	.....	.....	×	.....	.....	.....	.....	.....	26-	—	—	—	—	—	-5	.....	.....
91.	Yellow-bellied Flycatcher	.....	.....	.....	×	.....	.....	.....	.....	17-	—	—	—	-29	.....	.....	.....	.....
92.	Green-crested Flycatcher	.....	.....	×	.....	.....	.....	.....	.....	15-	—	—	—	—	-18	.....	.....	.....
93.	Traill's Flycatcher	.....	.....	×r	.....	.....	.....	.....	.....	.....	1885 14-	1885 —	1885 —	1885 -27	.....	.....	.....	.....
94.	Least Flycatcher	.....	.....	.....	×	.....	.....	.....	.....	21-	-19	.....	.....	.....	12-18	.....	.....	.....
95.	Prairie Horned Lark	×	.....	.....	.....	.....	—	—	—	—	n	—	—	—	—	—	—	—
96.	Blue Jay	×a	.....	.....	.....	.....	—	n	n	n	n	—	—	—	—	—	—	—
97.	Common Crow	×	.....	.....	.....	.....	—	—	n	n	—	—	—	—	—	—	—	—
98.	Bobolink	.....	.....	.....	×	.....	.....	.....	.....	17- Eggs	-6 Eggs	.....	.....	29-	-1	.....	.....	.....
99.	Cowbird	.....	.....	×a	.....	...	...	....	7-	—	—	—	—	—	—	-17	.....	.....
100.	Red-winged Blackbird	.....	.....	×	×a	.....	.....	.....	4-	—	—	—	—	—	—	—	-16	.. ..
101.	Meadowlark	.....	×r	×	.....	.....	r	a	—	n —	n —	—	—	—	—	—	—	r
102.	Orchard Oriole	.....	..	×	.....	.....	.....	.....	.....	17-	n —	—	—	29	....	.....	.....	.....
103.	Baltimore Oriole	.....	.....	×	×	.....	.....	.....	.....	18-	n —	n —	—	—	-2	.....	.....	.....
104.	Rusty Blackbird	.....	..	..	×	..	...	...	8-	—	-16	.....	.....	.....	.....	.....	15-21	.....
105.	Bronzed Grackle	....	×r	×a	.....	.....	r	r	a	n -	—	—	—	—	—	—	—	r
106.	Evening Grosbeak	.....	.....	.....	.....	×	1887 20	.....	.....	1887 27, 29. 30	.....	.....	.....	.....	.....	.....	.....	.....
107.	Purple Finch	.....	×r	.....	×	.....	.....	.....	8-	—	-4	.....	.....	.....	.....	.....	.....	.....
108.	American Crossbill	....	.....	×	.....	.....	18-	—	—	—	—	—	14	.....	.....	4-	-5	1885
109.	White-winged Crossbill	.....	.....	.....	.....	1883 ×	24	6, 10, 12, 23	.....	.....	.....	1896 24	.....	.....	.....	.....	.....	12
110.	Redpoll	.....	.....	.....	.....	×	1883 30	.....	.....	1895 12	.....	.....	.....	.....	.....	.....	.....	1882 —
111.	American Goldfinch	×a	..	.....	.....	.....	—	—	—	—	—	n	n	n	n	—	—	—
112.	Pine Siskin	.....	×r	.....	×	.....	—	—	—	—	-13	.....	.....	.....	.....	27-	—	—
113.	Snowflake	.....	.....	.....	.....	1886 r, w	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
114.	Lapland Longspur	.....	.....	.....	.....	r	.....	2-	-10	.....	.....	.....	.....	.....	.....	.....	.....	.....
115.	Vesper Sparrow	.....	.....	×a	.....	.....	.....	19-	—	—	—	—	—	—	—	-25	.....	.....
116.	House Sparrow	×a	.....	.....	... ..	.....	—	n	n	n	n	n	n	n	n	n	n	—

TABLE—Continued.

		Permanent Resident.	Winter Resident.	Summer Resident.	Regular Migrant.	Occasional Visitor or Migrant.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
117.	Savanna Sparrow			×r	×				30–	—	n —	n —	—	—	—	—	-6	
118.	Grasshopper Sparrow			×						12–	n —	n —				-4		
119.	Henslow's Sparrow			×r								n						
120.	Lark Sparrow			⁄a					26–	—	n —	n —	—	-26				
121.	Whit-crowned Sparrow				×					10–	-16					4-25		
122.	White-throated Sparrow			×r	×a		1903		8–	n —	n -16				24–	—	-22	
123.	Tree Sparrow		×a				29	—	—	-19						12–	—	—
124.	Chipping Sparrow			×a					16–	n —	n —	—	—	—	—	—	-9	
125.	Field Sparrow		× ?	⁄a				26	—	n —	n —	—	—	—	—	—	-8	
126.	Slate-colored Junco		×a				—	—	—	—	-1					6–	—	—
127.	Bachman's Sparrow			×	×					n 6–	n -8	—	—	—	?			
128.	Song Sparrow				×a		—	—	—	n	n	n	—	—		—	—	—
129.	Lincoln' Sparrow					×					1885 3-5					1885 10-25		
130.	Swamp Sparrow				×				5–	-29						2–	-3	
131.	Fox Sparrow		r		×		17	20—	—		-16					5–	-28	
132.	Towhee	×			×			22—	—	n	n	n	n	—		—		?
133.	Redbird	⁄					—	—	—	n		—		—		—	—	—
134.	Rose-breasted Grosbeak				×					23-	-16				11-	—	-12	
135.	Indigo Bunting			·a						13–	n —					-17		
136.	Dickcissel			×a						23–	n	n	—	—	—	-2		
137.	Scarlet Tanager			×	×					22	—	—			-19			
138.	Summer Tanager			⁄	⁄a					1-	n	n			-28			
139.	Purple Martin			×					28–	—	—	—	—	—	-10			
140.	Cliff Swallow			·	⁄a					12–	—	—	—	—	-14			
141.	Barn Swallow			⁄a	×a					9-	n	—	—	—	-12			
142.	Tree Swallow			1886	⁄a					5-30	1886	1886	1886	1886				
143.	Bank Swallow			×	×a					6–	—	— n	—	—				
144.	Rough-winged Swallow			⁄	×c					18-	n —	—	—	?				
145.	Cedar Waxwing			⁄						?	—	n	—	—	?			
146.	Northern Shrike					×		1902 8, 23									18	
147.	Migrant Shrike		×	⁄				16-	—	—	—	— n	—	—	—	—	—	-1
148.	Red-eyed Vireo			×a	×a					19-	n —	—	—	—	—	-2		

149.	Philadelphia Vireo			×r	×					28-	—	—	—	—	-28			
150.	Warbling Vireo			✓						21-	—	—		—	—	-10		
151.	Yellow-throated Vireo			×?	✓					16-	n-13	?	?	?	1-	-19		
152.	Blue-headed Vireo				✓r					28-	-17				16-24			
153.	White-eyed Vireo			✓a						17-	n —	—	—	—	-20			
154.	Black and White Warbler			×r	×					7	—	—	—	—	—	-4		
155.	Prothonotary Warbler					×r				26-	-28							
156.	Worm-eating Warbler			×	×					20-	n —	—	—	-31				
157.	Blue-winged Warbler			×r	×a					19-	—	—	—	—	-28			
158.	Golden-winged Warbler					×				27,28	1886 4							
159.	Nashville Warbler				×r					24-	-11			26-	—	-10		
160.	Orange-crowned Warbler					×					1885 4							
161.	Tennessee Warbler				×					26-	-16			30-	—	-17		
162.	Northern Parula Warbler					×				1885 1886 21-27								
163.	Cape May Warbler				×r					22-	-11				27-	-7		
164.	Yellow Warbler			×a						12-	n —	—	—	24				
165.	Blk.-throated Blue Warbler				×r					30-	-13				1-	-4		
166.	Myrtle Warbler		×		×		—	—	—	—	-13				24-	—	--	—
167.	Magnolia Warbler				×						5-24			31-	—	-4		
168.	Cerulean Warbler			×r	×					23	-7	r	r	r				
169.	Chestnut-sided Warbler				×					21-	-10			28-	-15			
170.	Bay-breasted Warbler				✓r					29-	-13				18-	-10		
171.	Black-poll Warbler				×r					28-	-19				18-	-28		
172.	Blackburnian Warbler				×r					21-	-14			27-	—	-10		
173.	Sycamore Warbler			×	✓					12-	—	—	—	—	—	-9		
174.	Blk.-throated Green Warbler				×a					18-	-16				1-	-17		
175.	Pine Warbler				×r					23-26					7-29			
176.	Palm Warbler				×					23-	-13				22-27			
177.	Prairie Warbler				×r					26-	-16							
178.	Oven-bird			×						19-	—	—	—	—	—	-12		
179.	Water Thrush				×				27-	—	-5				14-18			
180.	Grinnel's Water Thrush					×r				1886 23								
181.	Louisiana Water Thrush			×					×	—	n —	—	—	—	-1			
182.	Kentucky Warbler			×						13-	n —	n —	—	-26				
183.	Connecticut Warbler					×r				1886 27	1886 1887 6-18							
184.	Mourning Warbler					×r					1885 16-27							
185.	Maryland Yellow-throat			×a						20-	—	n —	—	—	—	-19		
186.	Yellow-breasted Chat			×a						24-	n —	—	—	—	-28			

TABLE—Continued.

		Permanent Resident.	Winter Resident.	Summer Resident.	Regular Migrant.	Occasional Visitor or Migrant.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
187.	Hooded Warbler			×r						20-	n —	n —	—	—	-14			
188.	Wilson's Warbler				1885						8-14			31-	-18			
					1886 ×r													
189.	Canadian Warbler				×					27-	-18			26-	-15			
190.	American Redstart			×	×a					12-	n —	n —	—	—	—	-19		
191.	American Pipit				×					1-	-19							
192.	Mockingbird			×					24-	n —	—	—	-6	—	—			
193.	Catbird			×a						2-	n —	n —		—	—	-6		
194.	Brown Thrasher			✓					16-	n —	n —	n —		—		-12		
195.	Carolina Wren	×					—	—	—	—	—	—	—	—	—	—	—	—
196.	Bewick's Wren			×					n6-	n —	—	—	—	—	—	-12		
197.	House Wren			×r					9-	n —	— n	—	—	—	-16			
198.	Winter Wren		×r				—	—	-3						4-	—	—	—
199.	Long-billed Marsh Wren					×r					10, 13				29			
200.	Brown Creeper					×	r	r	a	a	-30				27-	a	a	r
201.	White-breasted Nuthatch	×					—	—	n	—	—		—	—	—	—	—	—
202.	Red breasted Nuthatch		×r			×	—	—	—	—	-12				20	—	—	—
203.	Tufted Titmouse	×a					—	—	—	n	n			—	—	—	—	—
204.	Chickadee		×				—	—	—	—	-15						7	—
205.	Carolina Chickadee	×					—	—	—	n	n	—	—	—	—	—	—	—
206.	Golden-crowned Kinglet		×r		×a			4-	—	—	-7				21-	—	-28	
207.	Ruby-crowned Kinglet				×a				23-	—	-18				21-	-24		
208.	Blue-gray Gnatcatcher			×						n5-	n —	—	—	—	-12			
209.	Wood Thrush			×						12	n	—	—	—	—	-12		
210.	Wilson's Thrush				×r					24-	-16				1-13			
211.	Gray-cheeked Thrush				×					10-	-17				2-25			
212.	Olive-backed Thrush				×r					28-	-19				1-	-2		
213.	Hermit Thrush				×				23-	—	-3					3-	-21	
214.	American Robin	×					r	r	n, a	n, a	n, a	n, a	a	a	a	a	a	r
215.	Bluebird	×					c	c	n, a	n, a	a	a	a	a	a	a	a	c

*The tables and index were prepared by Charles Henry Frazee and Leonard Haseman from the data contained in Mr. McAtee's paper.

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Electromagnetic Induction in Conductors of Different Materials and in Electrolytes.

Arthur L. Foley and Chester A. Evans.

This investigation was undertaken for the purpose of determining whether or not the character of a conductor has any effect upon the electro-motive force generated in it when it is made to cut magnetic lines of force.

Is the e. m. f. generated in a copper wire of given length exactly equal to the e. m. f. generated in a silver wire of the same length when both cut lines of force at the same rate? And is this e. m. f. equal to that generated in a nonconducting tube of length l. filled with an electrolyte, when the electrolyte is made to cut lines of force at the above rate? Electrolytic conduction and metallic conduction appear to be very different processes, why then should one expect metals and electrolytes to give identical results from electromagnetic induction?

It is evident that many difficulties and sources of error will be avoided if the two conductors to be tested can be placed together and made to cut the same field in such a manner that the resultant e. m. f. generated is zero, provided that electromagnetic induction is independent of the substance of the conductor. Also, the direction of the e. m. f. must be constant if a sensitive galvanometer is to be used to detect it.

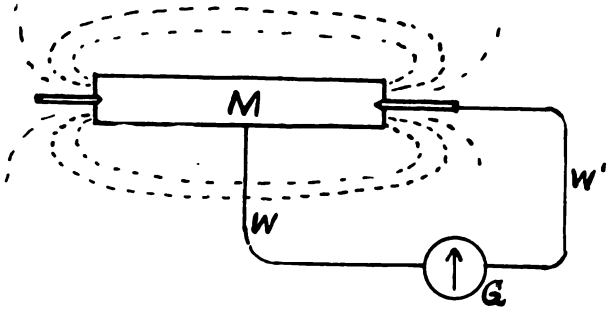


Fig. 1.

Let M (Fig. 1) be a cylindrical magnet mounted to revolve about its axis, and let w and w' be wires in contact respectively with the middle of the magnet and the center of the end, and connected, as shown, to a gal-

vanometer, G. Suppose the magnet to be revolved at a high speed. Few lines of force cut w^1, as it is parallel with the axis of the magnet. W is cut by the lines passing from pole to pole and if the pole strength is sufficiently great and the magnet is revolved rapidly, the galvanometer will indicate a current—and therefore an induced e. m. f. If w and w^1 are led from the magnet as in Fig 2, it is evident that the resultant e. m. f. generated is zero, since that generated in w opposes that generated in w^1. But suppose that w is of one metal and w^1 of another, if the e. m. f. generated in each is not the same, the galvanometer, if sufficiently sensitive, will indicate a current. The wire w^1 may be replaced with a tube containing an electrolyte and the electromagnetic induction in the electrolyte measured. To increase the sensitiveness of the apparatus there may be a number of w's and w^1's connected as shown in Fig. 3.

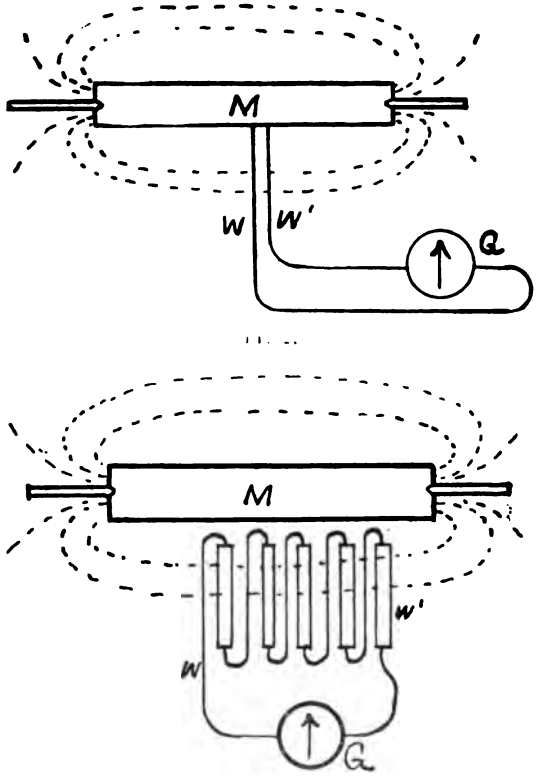


Fig. 3.

Although considerable work has been done, it has been entirely of a preliminary character. With a magnet of pole-strength 415, making 4,000 revolutions per minute, with 100 copper wires (w) and 100 German silver wires (w^1), the junior author of this paper found that no current was indicated by a galvanometer whose constant was 1.1×10^{-6}. The magnet was rotated by an electric motor and the galvanometer was placed on a pier in an adjoining room some thirty feet distant. Work with electrolytes is now in progress.

The senior author is arranging to make the apparatus more sensitive by using an electromagnetic field and a more delicate galvanometer. Results will be given in a future paper.

Interference Fringes About the Path of an Electric Discharge.

Arthur L. Foley and J. H. Haseman.

Some ten years ago the senior author of this paper, while photographing interference fringes under various conditions, noticed that fringes were produced about the path of an electric discharge. Owing to the press of other work further investigation of the subject was postponed. A few weeks since the subject was revived and arrangements were made to continue the investigation.

The apparatus consists of two rectangular wood boxes about twelve feet long, the larger box about eight inches square, the smaller one about six inches square and arranged to telescope in the larger box. Thus the total length of the box can be made anything from twelve to twenty-four feet. The boxes were painted dead black on the inside. The far end of the larger box is provided with a sort of camera attachment and plate holder. The far end of the smaller box is light tight, except for a metal disc, which has several apertures bored through it, the apertures varying in diameter from .01 cm. to .5 cm. By rotating the disc any desired aperture can be brought into position at the center of the end of the box. The aperture was illuminated by the blue end of the spectrum of an electric arc. A piece of ground glass was placed against the outside of the metal disc to insure the spreading out of the light passing through the aperture.

The needle points were placed near the center of the box, which was made about twenty feet long. The points were charged by connecting them to the knobs of a ten-inch plate induction machine driven by an electric motor.

Interference fringes were produced whether the discharge was visible or invisible, continuous or intermittent, and whether between points or small spheres. On some of the plates taken with the needle points 1 cm. apart and with an invisible discharge three dark bands can be seen on either side of the dark central band connecting the two points.

Sufficient work has not been done to warrant an attempt at an explanation of the results obtained, therefore further results will be reserved until others have been obtained that may throw some light on the subject.

Cuscuta Americana L.

Stanley Coulter.

In a study of the genus Cuscuta a peculiar situation in regard to Cuscuta Americana L. arose, which may prove of interest. The history of this species seems evident. The original plant was collected by Sir Hans Sloane in Jamaica and is described in Hist. Jamaica, 1707, vol. 1, p. 201. Gronovius in 1743 determined a specimen collected by John Clayton to be the same as the Sloane plant, to which he definitely referred: Plantæ Virginica, p. 18: 1743. Linnæus, 1753, in Sp. Pl., vol. 1, p. 124, copies the description of Gronovius verbatim and gives the form its binomial name. Linnæus refers specifically to Pl. Virg., p. 18.

It is clear, then, that Sloane's plant in the South Kensington Museum should stand as the type of Cuscuta Americana L. That as a matter of fact our present Cuscuta Americana L. is a very different plant from that of Sir Hans Sloane will perhaps be clear from the discussion which follows. Indeed, Cuscuta Americana L. as at present understood seems to have arisen without a type upon which to rest.

Through the courtesy of the authorities of the South Kensington Museum I was enabled to study the Sloane plant somewhat carefully, with the following results:

Calyx gamosepalous; tube short; lobes coriaceous in center, membranous at edges; diverging at an acute angle; apex abruptly acute; large cells (plainly made out with hand lens) irregularly scattered; membranous part of lobes, as well as inner and outer surface of petals, thinly clothed with velvety trichomes. Lobes of calyx one-half longer than the tube, the tips meeting those of the reflexed lobes of the corolla. Lobes rather spreading, at least not closely appressed to tube of the corolla.

Corolla; tube urceolate, about 2 mm. long; lobes reflexed, obtuse, separating from each other by a narrowly acute angle, about one-half as long as the tube. In many cases margins of petals infolded, which, however, may be due to imperfect drying.

Stamens apparently four, about one-half as long as lobes of the corolla, though exserted on account of the reflexed habit of the lobes.

Styles as long as tube of corolla, widely diverging.

Stigmas decidedly globose-capitate.

Inflorescence in cymose clusters of various sizes; peduncles often branched; pedicels, which are of varying length, bearing a single flower. Peduncles very generally stronger than the stems from which they arise. Pedicels in the majority of instances from 10 to 15 mm. long. Sloane's note that flowers arise from "single side of stalk" seems well taken, though his added statement, "as others of this kind are," needs modification.

Stem, closely appressed to stem of host where haustoria are developed and in such places strengthened and roughened. It also presents a large number of free ends which branch somewhat freely, each branch being subtended by an evident leaf-scale from 1 to 3 mm. long. The free branches have a twisted appearance and twine freely about each other. The plant as a whole is straw colored.

The abundant material permitted the dissection of the flowers, giving the following additional characters:

Flower generally four-parted, in this differing from the majority of American Cuscutas.

Anthers somewhat sagittate, filaments strong.

Scales large, about one-half length of filament; united at base; deeply cleft near top, less deeply at sides, intervening arch not fringed.

Sepals narrowly elliptical, the acumination being really a cuspidation.

Petals delicate in structure with but few large cells; elliptical, obtuse; reflexed fully one-third of their length.

Ovary lenticular, rather sharp-edged. In early anthesis styles are about length of ovary; later they become as long as corolla and very prominent. The styles are somewhat thick, awl-shape, and the globose character of the stigma is apparent from the first.

This is Sloane's Jamaica plant as I was able to make out its characters after an extremely careful study.

The Linnæan description in Sp. Pl. (1753), p. 124, is as follows:

"C. Americana.

Cuscuta floribus pedunculatis.

Cuscuta caule aphyllo volubili repente (Gron. Fl. Virg. p. 18).

Cuscuta inter majorem et minorem media, filamentis longis et floribus late super arbores et campos se extendens. Habitat in Virginia."

This is a verbatim copy of Gronovius' description of "Cuscuta inter majorem et minorem media" in Flora Virginica, Pas Prima, p. 18. 1743.

Gronovius in turn closely followed the description of Sloane in his Hist. Jamaica, vol. 1, p. 201 (1707), t. 128, f. 3, his added characterizations being of very doubtful value.

Through the courtesies of the officials of the Linnæan Society I was able to examine the Cuscutæ in the Linnæan collection. This collection had evidently been examined by Dr. Engelmann in his study of the genus and his penciled annotations were upon the various sheets. There are three sheets, each of which is labeled C. Americana in the well known writing of Linnæus. One of these is evidently Cuscuta Gronovii Willd, and Dr. Engelmann so regarded it, as is shown by his annotation. Another is probably Cuscuta umbellata H. B. K., at least it was so referred by Dr. Engelmann, and whether the reference be correct or not, the plant is certainly *not* the same as that upon the other two sheets. It is on the plant upon the remaining sheet that Dr. Engelmann rests his conception of the Cuscuta Americana of Linnæus. It might be a fair question, in passing, as to why either of the other sheets might not have been selected as the basis of the Linnæan C. Americana.

The plant upon the third sheet, then, is to be taken as representing the notion of Linnæus of the species under consideration. The specimen upon this sheet conforms fairly to Engelmann's description and also to that of Choisy, 1841, although it might be said that Choisy's figures of C. Americana L. in Choisy's Cuscuta, Jan. 21, 1841, No. 51, p. 186 tab. 4, f. 4, could not have been derived from his description of the species in his "Cuscuta enumeratio." The most cursory comparison of the description and drawings will make this fact plain.

The form upon this sheet, however, is not the same as Sloane's plant. A careful study and dissection of the plant gives the following characters:

Calyx 5-parted, polysepalous; lobes oval, acute, diverging from each other at an acute angle, coriaceous throughout, about as long as calyx tube. The calyx is quite large, being scarcely exceeded by the corolla. No evidence of large cells, although under hand lens the texture of the sepal is seen to be coarse, simulating veining.

Corolla 5-parted. Tube at first cylindric, later somewhat urceolate because of increase in size of ovary. Tube scarcely longer than calyx. Lobes, oval, acute, finally reflexed about one-fourth length of tube; in young flowers erect or spreading. Delicate in structure, no evidence of large cells.

Stamens, scarcely exserted, in the majority of cases not at all. Filaments strong, anthers *not* sagittate.

Scales about one-half the length of the petals, united at the base, arch narrow; top of scale deeply fringed, the fimbriations often branching; sides of scales much less deeply fringed, arches not at all. Base of scales plainly bilobate, as is often, though not always the case.

Styles two, parallel, short, subequal, scarcely exserted, in the majority of cases not at all.

Ovary somewhat globose, showing slight tendency toward triangularity, evidently due to development of three seeds. Styles only about one-half the length of ovary; stigmas globose-capitate.

Flowers from 2-4 mm. long and nearly as broad.

Inflorescence: Flowers gathered in clusters of various sizes, though none of the clusters exceed 8 mm. in diameter. Clusters contain from 3-5, up to 10-16 flowers. Flowering branches thickened, rugose, often branched. Pedicels short, single flowered, the flowers in many cases seeming sessile.

Scale leaves small, sub-triangular, acute, membranaceous.

Stem, where closely appressed to host-plant, strong, rugose, dark colored, almost brown. Free stems slender smooth, often branching. Scale leaves, more elongate and less acute than those found on flower branches, occur on free portions of the stem.

The individual flowers have no bracts, although the floral clusters are subtended by two or more membranaceous bracts from 1-2 mm. long and perhaps two-thirds as wide.

It is very evident that the plant in the Linnæan collection is far removed from the Jamaica plant of Sloane in the South Kensington Museum.

Grisebach, in Fl. of British West Indies, London, 1864, includes Americana and makes direct reference to Sloane, t. 128, f. 4, but the description shows that the plant he so refers is not that of Sloane. The following characters (Fl. Brit. West Ind. (1864), p. 476) mark his plant:

1. Pedicels shorter than flowers.
1. Calyx little exceeded by corolla.
3. Calyx lobes short, rounded.
4. Corolla 5-parted, lobes erect.
5. Scales small.

That much confusion has resulted from this uncertainty as to the type feature of Cuscuta Americana L. is evidenced by a study of the various large herbaria.

Thus the C. graveolens H. B. K. (Nov. Gen. et Sp. 3, p. 122, 1818) can scarcely be a synonym of C. Americana L. if the description there given is at all accurate.

In the collections at the Kew gardens, 21809 and 21810, Dr. A. Glazier, Brazil, chiefly from Province of Goyaz, 1896, are neither the C. Americana of Linnæus and Engelmann, nor yet are they Sloane's plant. Herb. Guatemalens, 59, Jan., 1864, Gust. Bernoulli, and Herb. Guatemalens, 1916, Bernoulli and Cairo, with Herb. Mus. Paris 3353, Region de Orizaba, M. Bourgeau, 1865-1866, all mounted on same sheet and labeled C. Americana are C. congesta.

Ex Plantis Guatemalensibus, quas edidit John Donnell Smith, No. 855, C. Americana L. forma floribus majusculis, Coban, Dept. Alta Verapaz. Altitude 4,300 feet. January, 1886. Legit H. von Tuerckheim, is neither C. Americana nor a variety of it; the long slender, acuminate corolla lobes evidently throwing it in quite a different section of the genus.

Such a list might be greatly extended, but enough has been indicated to show into what inextricable confusion we have come because of this absence of a recognized type form for this species.

Personally I am not attempting any decision in the matter; I am simply reciting facts coming under my observation. If Sloane's Jamaica plant is the type of C. Americana L., then the form in the Linnæan collections, so labeled by Linnæus and reaffirmed by our last specialist in the group can not be C. Americana, for it is not the same plant. If the form in the Linnæan collection be taken as the type, what is the name of Sloane's plant? How, also can it be assumed that any other plant than Sloane's was in mind in view of the references of Gronovius and Linnæus to it specifically, references continued as late as 1797, when in Linne Sp. Pl. Willdenow, edn. IV., vol. 1, page 702, we find at the conclusion of the characterization, "Habitat in Virginiæ fructibus et at littora maris in herbis Jamaicæ (v. s.)"? Gmelin, also in his Sys. Veg., 1796, vol. 1, p. 285, refers to Sloane's plant, as does also Vitman in his Summa Plant, 1790, vol. 1, p. 340.

How the riddle shall be read in view of these facts is left to adepts in nomenclature. It is entirely beyond my powers.

On the Nomenclature of Fungi Having Many Fruit-Forms.

J. C. Arthur.

(Abstract.)

The paper begins with a statement of the views of Dr. Magnus and others, who hold that with such forms as the heteroecious rusts the action of the law of priority in the selection of specific names should extend only to names applied to the teleutosporic form. Thus, the common grain rust should be called *Puccinia graminis* Pers., and not *Puccinia poculiformis* (Jacq.) Wettst.

The argument is upheld that this view practically rests upon the inference that the genus Puccinia is a form-genus based upon the teleutosporic stage. A true genus, it is maintained, must of necessity embrace all stages of development and all structural parts of every species under it. The name of the genus, as well as that of the species must, moreover, so far as its nomenclatorial treatment is concerned, be considered as simply appellative, and without regard to its derivation or significance.

These ideas are elucidated with a variety of illustrations. The conclusion is drawn that with clear concepts of this nature there can be no question of the desirability of applying the law of priority to fungi with many fruit-forms, in a manner similar to its use among phanerogams.

The proper name for the common grain rust, according to this method, is *Puccinia poculiformis* (Jacq.) Wettst.

Pollination of Campanula Americana and Other Plants.

Moses N. Elrod.

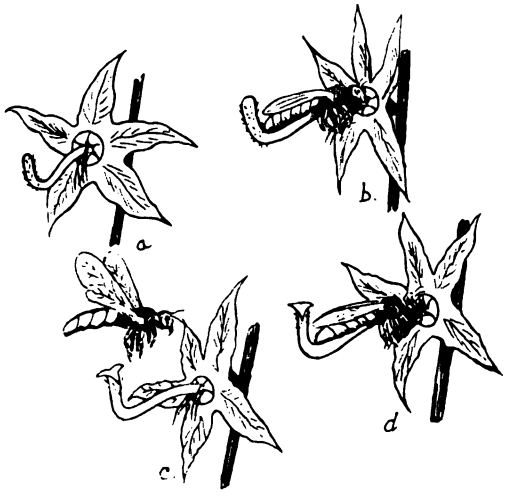
Campanula Americana L. is markedly proterandrous. In the bud the anthers are in contact with the pilose two-thirds of the style and discharge their pollen introrsely before the corolla opens. As the flower bud opens the filaments wither beyond their more persistent bases. In the meantime the style grows rapidly in length, so that in a few hours it is long-exserted, declined and the pilose, pollen covered end turned upward. No matter whether the flower is on an erect or inclined branch the pilose end always turns upward, while the other portion of the style assumes a horizontal or slightly declined position. One or two days after the bud has opened the hairs on the style begin to wither and drop their charge of pollen. At the same time stigmatic papillæ are exposed and ready for cross-pollination. Nectar is secreted by a fleshy disk surrounding the base of the style, and is protected from rain and the predatory incursion of many insects by the triangular bases of the five stamens.

Honey-bees and the beautiful metallic-green *Agaostemon radiatus* Say are frequent visitors. They readily gain access to the honey by lighting on the petals of the rotate corolla and inserting the tongue between the style and bases of the stamens. Their visits, however, do not promote fertilization, as their movements, in approaching the flower or in collecting honey, never bring them into contact with the pollinated portion of the style nor do they ever touch the stigma.

C. Americana is cross-fertilized by a leaf-cutter bee, *Megachile brevis* Say. It differs from the honey-bee in its structure and the way in which it approaches the honey disk. It is armed with a dense brush of hairs on the under side of the tail, instead of having pollen baskets on the legs; it comes to the flower on the wing, in a direct, unhesitating way, over the upturned stigma, which it frequently touches with the hairs of its tail; it settles on the style with its head directed away from the stigmatic end of that organ, and never comes in contact with the corolla except with its fore feet. While in this position collecting honey the

Note.—I am indebted to Mr. Ashmead, Bureau of Entomology, Department of Agriculture, for identifying the bees named in this paper.

hairs of its tail are in contact with the pilose portion of the style and become pollinated, if the flower has recently come into bloom and the style has not yet shed its hairy coating. But this leaf-cutter is not wholly dependent on its position while collecting honey for a supply of pollen. On several occasions it was seen clinging to the style and transferring pollen to its abdomen with its hind-legs, a maneuver that no other bee seems capable of performing. With the hairs of its tail charged with pollen it is easy to understand how cross-fertilization is effected, as it passes from one flower to another; and so systematic are the movements that they appear to be evolved for the purpose they fulfil. So far as the writer has been able to discover, no other insect than *M. brevis* is of use in fertilizing the tall bellflower. Another leaf-cutter, *Megachile infragilis* Cresson, was often seen collecting honey from *Impatiens aurea*



Figures. CAMPANULA AMERICANA L.
a. Triangular bases of stamens.
b. Pilose end of style covered with pollen and bee collecting honey.
c. Style denuded of hairs, bee about to brush against lobes of stigma.
d. Style denuded of hairs and bee in position on style while collecting honey.

Muhl. and pollen on *Helianthus annuus* L. growing nearby, but was never seen on *C. Americana*.

The tall bellflower, on which the observations described were made, grew in the back yard of a city residence, and was in bloom from July

to November 8, 1904, at which last date forty-seven perfect flowers were counted. Long before November heavy frost had ended all insect visits and the plant had been dependent on self-pollination for fertilization for a month. With frost came some noticeable changes in the mechanism of the flower. The end of the style was not so uniformly bent upward, and the pollen-bearing hairs were much more persistent. During the latter period self-fertilization was effected by the lobes of the stigma bending back until the papillose extremities touched the pollinated hairs. The same movement may have occurred earlier in the season, but if it did it was not so obvious, and many times it would have been useless, as the styles were denuded of their hairy appendages, and the lobes not yet reflected more than usual.

Within the inflated limb of *Pentstemon Pentstemon* (L) Britton the filaments are free, and clustered with the style under the upper lip. One pair of the didynamous filaments is nearly free from the corolla tube, while the other pair and the sterile filament are imbedded in the wall of the tube below the inflation. The bases of the free filaments are dilated, with a concavity on the inner faces in which honey is secreted.

As a result of this arrangement the throat of the corolla is so obstructed by the two free filaments and the style as to prevent any insect from reaching the honey glands, without some special adaptation to overcome the obstruction. To secure honey the visiting insects must be armed with a stout pair of jaws to force an opening between the filaments and style and with a tongue 14 mm. long. These necessary equipments are found in *Anthophora abrupta* Say, a small bumble-bee. For two seasons this bee has been the only insect seen to enter the corolla of a large, cultivated plant, under daily observation while in bloom. Anthophoræ never missed putting in an appearance during some part of the day, if the weather was fair, and sometimes as many as half a dozen were seen on the plant at the same time.

Anthophoræ abruptæ never were seen collecting pollen, but as they forced their bodies into the inflated portion of the flower they were well dusted with it on their hairy backs. This pollen was carried to the next stigma under which they passed, where some of it was left, provided the stigma was ready to receive it. Usually the stigmatic end of the style is pressed against the upper lip of the corolla during the first day of anthesis, after that period it is bent downward and is cross-fertilized

by coming into contact with the pollinated back of a passing Anthophora in search of honey. There does not seem to be any provision for the self-fertilization of *P. Pentstemon.*

The longer of the dimorphic pistils of *Mertensia Virginica* (L) D.C. are of the same length as the stamens and may be self-fertilized by contact with the dehiscing anthers. The shortest of the other form do not reach beyond the end of the narrow tube, and are fertilized by honey-bees. Honey is secreted at the base of a tube 25 mm. long and is further protected by a pubescent ring 2 mm. above the receptacle. No insect was found on the flowers that could reach the honey in a legitimate way, but a big bumble-bee was seen on the corolla making slits in the tube just above the pubescent ring. Through the opening the tongue of the bee was inserted and the honey removed, with ease, as it passed rapidly from one flower to another.

A calendine poppy, *Stylophorum diphyllum* (Mich.) Nutt., under cultivation came into bloom April 23, early in the forenoon. At 3:40 p. m. the petals began closing and by sundown were completely folded over the stamens. Although it was raining the next day the petals under observation again opened in all their golden splendor. It was not clearly evident that the stamens of this plant were proterandrous, though the stigma greatly increased in size after the bud had opened. Usually the flowers did not wither under two days. Small bees were noticed crawling on the flowers, a single honey-bee was seen collecting pollen, and it is probable cross-fertilization was the result of their movements. Flowers protected by a net from insect visitors produced capsules of the normal size, well filled with seeds.

In July it was noticed that while the calendine poppy was producing an abundance of seeds none could be found on the ground under the plant. The seeds of a dehiscing capsule, which were placed in a heap on a small stone, all disappeared by next morning. When it was recalled that ants are known to carry small seeds into their nests they were suspected of carrying them away. This inference seemed probable, as the seeds were provided with a fleshy crest on one edge which an ant could grasp. At last a common black ant, about 6 mm. long, was seen with a seed in its mouth and watched until it disappeared in a round hole. Later an ant was followed to another hole. The mouth to these holes was level with the surface of the ground and not through the usual hillock of sand

of their nesting places. They were located 5 dm. from the stem of the plant, and when opened were found to be about 6 mm. deep. One of them was tunnelled along the edge of a rotten chip and contained seven seeds. The crest of one of the seven seeds was withered while the papillæ of the others were plump. Nothing was seen to indicate that they had been stored for food or that the crest contained anything they cared to eat.

Additions to the Indiana Flora.

Chas. C. Deam.

In addition to the species taken by myself, this list contains fourteen species I received through an exchange with L. M. Umbach, Napersville, Ill., and one from E. B. Williamson, Bluffton, Ind. I have a sheet of all the plants reported in my herbarium. My species have all been verified at the National Museum.

Panicum boreale Nash.

In the swales at Miller, Ind., June 28, 1898, by L. M. Umbach.

Panicum macrocarpa Le Conte.

Wells County, May 31, 1903; Steuben County, June 17, 1903; Dune Park, June 16, 1900, L. M. Umbach. September 4, 1901, by Agnes Chase.

Aristida intermedia Scribn. & Ball.

In moist sands at Miller, Ind., October 2, 1898, by L. M. Umbach.

Elymus glaucus Buckley.

In sand at Pine, Ind., June 29, 1898, by L. M. Umbach.

Eleocharis obtusa Schultes.

Wells County, August 23, 1897; Miller, Ind., July 20, 1898, by L. M. Umbach; Steuben County, July 3, 1904; Noble County, July 21, 1904.

Correction.

Reported by Stanley Coulter in Indiana Academy 1900 page 137.

Psilocarya nitens (Vahl.) Wood.

In sloughs at Dune Park, Ind., September 12, 1899, by L. M. Umbach.

Psilocarya scirpoides Torr.

In sloughs at Dune Park, Ind., September 2, 1898, by L. M. Umbach.

Wells County, May 13, 1905.

Carex festucacea Willd.

In swales at Clarke, Ind., June 4, 1898, by L. M. Umbach

Clintonia boreale (Ait.) Raf.

In swamp at Miller, Ind., May 14, 1898, by L. M. Umbach.

Salix Bebbiana **Sarg.**

In marsh at Clarke, Ind., May 7, 1898, by L. M. Umbach.

Salix amygdaloides **Anders.**

In marsh at Lake Station, Ind., May 12, 1900, by L. M. Umbach.

Chenopodium glaucum **L.**

In ballast at Miller, Ind., August 26, 1898, by L. M. Umbach

Froelichia Floridana **(Nutt.) Moq.**

In ballast at Aetna, Ind., July 7, 1900, by L. M. Umbach.

Silene vulgaris **(Moench.) Garcke.**

In ballast at Pine, Ind., June 17, 1899, by L. M. Umbach.

Heuchera hirsuticollis **(Wheelock) Rydb.**

Steuben County, July 4, 1904.

Oxalis Brittoniae **Small.**

Wells County, September 1, 1904; Steuben County, September 9, 1904.

Oxalis grandis **Small.**

Orange County, May 25, 1901; Franklin County, May 28, 1904.

Ilex Bronxensis **Britton.**

Wells County, June 11, 1899; Steuben County, July 4, 1904.

Hypericum boreale **(Britton) Bicknell.**

Wells County, in low border of lakes in Jackson Township, September 6, 1903.

Viola papilionacea **Pursh.**

Wells County, in woods, May 3, 1903.

Helianthemum majus **(L.) B. S. P.**

On wooded gravelly hills in Steuben County, August 13, 1903.

Epilobium palustre **L.**

Wells County, August 18, 1901; Steuben County, August 13, 1903.

Bartonia ionandra **Robison.**

Steuben County, September 11, 1904.

Apocynum hypericifolium **Ait.**

Noble County, near Rome City, July 21, 1904.

Apocynum pubescens **R. Br.**

Kosciusko County, July 28, 1904.

Teucrium occidentale **A. Gray.**

Steuben County, in swamp near Gage Lake, August 12, 1903; Kosciusko County, in swamp on east side of Winona Lake, July 28, 1904.

Lycopus communis **Bicknell.**

Wells County, September 2, 1900; Steuben County, August 11, 1903.

Physalis heterophylla **Nees.**

Wells County, August 22, 1899; Steuben County, September 11, 1904.

Physalis Virginiana intermedia **Rydb.**

Steuben County, June 17, 1903.

Viburnum cassinoides **L.**

Steuben County, June 12, 1904, in clearing.

Triosteum arundinaceum **Bicknell.**

Wells County, May 22, 1898.

Chrysanthemum Balsamita **L.**

Adams County, September 20, 1903, by E. B. Williamson. Escaped.

Bidens vulgata **Greene.**

Wells County, September 4, 1904.

Carduus Hillii **(Canby) Porter.**

Steuben County, June 17, 1903. Only two specimens collected. On wooded hillside one-half mile southeast of Gage Lake.

Additions to the Flora of Marion County, with Notes on Plants Heretofore Unreported from the State of Indiana.

Benj. W. Douglass.

1. *Woodsia obtusa* Torr.
2. *Dulichium arundinaceum* Britton.
3. *Scirpus debilis* Pursh.
4. *Carex lupulina* Muhl.
5. *Carex comosa* Boott.
6. *Trillium sessile* L.
7. *Trillium erectum* L.
8. *Polygonum Virginianum* L.
9. *Allionia nyctaginea* Michx.
10. *Nymphæa advena* Soland.
11. *Nelumbo lutea* Pers.
12. *Caltha palustris* L.
13. *Delphinium trichorne* Michx.
14. *Clematis Viorna* L.
15. *Thalictrum dioicum* L.
16. *Berberis vulgaris* L.
17. *Jeffersonia diphylla* Pers.
18. *Arabis dentata* T-G.
19. *Cleome spinosa* L.
20. *Opulaster opulifolius* Kuntze.
21. *Comarum palustre* L.
22. *Rosa humilis* Marsh.
23. *Amelanchier Canadensis* Medic.
24. *Crataegus Crus-Galli* L.
25. *Robina pseudacacia* L.
26. *Meibomia nudiflora* Kuntze.
27. *Meibomia rigida* Kuntze.
28. *Lespedeza repens* Bart.
29. *Strophostyles helvola* Britton.
30. *Oxalis violaceae* L.
31. *Linum usitatissimum* L.
32. *Ptelea trifoliata* L.
33. *Euphorbia corollata* L.
34. *Euphorbia commutata* Engelm.
35. *Ilex verticillata* Gray.
36. *Vitis æstivalis* Michx.
37. *Hypericum prolificum* L.
38. *Hypericum sphærocarpum* Michx.
39. *Hypericum perforatum* L.
40. *Hypericum maculatum* Walt.
41. *Hypericum mutilum* L.
42. *Triadenum Virginicum* Raf.
43. *Viola tenella* Muhl.
44. *Cubelium concolor* Raf.
45. *Aralia racemosa* L.
46. *Panax quinquefolium* L.
47. *Thaspium barbinode* Nutt.
48. *Conium maculatum* L.
49. *Cicuta maculata* L.
50. *Cornus alternifolia* L.
51. *Nyssa sylvatica* Marsh.
52. *Hypopitys hypopitys* Small.
53. *Steironema quadriflorum* Hitchc.
54. *Diospyros Virginiana* L.
55. *Gentiana Audrewsii* Griseb.
56. *Ipomœa pandurata* Meyer.
57. *Hydrophyllum Virginicum* L.
58. *Hydrophyllum Canadense* L.
59. *Mertensia Virginica* D. C.
60. *Scutellaria cordifolia.*

61. *Koellia flexuosa* MacM.
62. *Koellia Virginiana* MacM.
63. *Lycopus Americanus* Muhl.
64. *Mentha spicata* L.
65. *Physalis Virginiana* Mill.
66. *Collinsia verna* Nutt.
67. *Mimulus ringens* L.
68. *Afzelia macrophylla* Kuntze.
69. *Gerardia tenuifolia* Vahl.
70. *Houstonia cærulea* L.
71. *Houstonia ciliolata* Torr.
72. *Triosteum perfoliatum* L.
73. *Lobelia spicata* Lam.
74. *Nabalus altissimus* Hook.
75. *Vernonia Noveboracensis* Willd.
76. *Solidago Canadensis* L.
77. *Euthamia graminifolia* Nutt.
78. *Antennaria plantaginifolia* Richards.
79. *Gnaphalium obtusifolium* L.
80. *Dysodia papposa* Hitchc.
81. *Erechtites hieracifolia* Raf.
82. *Mesadenia atriplicifolia* Raf.
83. *Senecio aureus* L.

New State Plants.

Tradescantia brevicaulis Raf.

Short stemmed spiderwort. Growing on hillsides near Alliance, Marion County.

Tradescantia bracteata Small.

Long bracted spiderwort. Found in similar localities to the last and associated with it.

Thlaspi arvense L.

Penny Cress. On R. R. near Indianapolis. Rare.

Sisymbrium altissimum L.

On R. R. near Broad Ripple, Marion County. Rare.

Camelina microcarpa Andrz.

Waste fields near Fair Grounds at Indianapolis.

Physostegia parviflora Nutt.

Western Lion's Heart. Along White River at Broad Ripple, Marion County.

Solanum Torreyi A. Grey.

Dry fields, Hancock County. Spreading. Reported to me by Jacob Schramm.

Houstonia tenuifolia Nutt.

Slender leaved Houstonia. Dry hills in northern part of Marion County.

Additions to the List of Gall-Producing Insects Common to Indiana.

Mel T. Cook.

Two years ago the writer presented a list of forty species of gall-producing insects common to Indiana. One year ago an additional list of eleven species was presented to the Academy. It was at first intended to make as complete a list as possible and then to give a more extensive discussion of these very interesting insects and the abnormal growths produced by them. However, a change of residence has made a change of plans necessary.

The following is a list of species which have come to my attention within the past year and previous to my leaving Indiana.

Hemiptera.

52. *Pemphigus vagabundus* Walsh.—*Populus deltoides* Marsh.
53. *Hamamelistis spinosus* Shimer. *Hamamelis Virginiana L.*

Diptera.

54. *Cecidomyia clavula* Bent. *Cornus florida* L.
55. *Cecidomyia cerasi-serotinae* O. S. *Prunus serotinae* Ehrh.

Hymenoptera.

56. *Amphibolips prunus* Walsh. *Quercus sp.* .....
57. *Cynips pisum* Fitch. *Quercus alba* L.
58. *Dryophanta radicola* Ashm. *Quercus alba* L.
59. *Neuroterus rileyi* Bassett. *Quercus prinus* L.
60. *Rhodites radicum* O. S. *Rosa carolina* L.
61. *Rhodites dichlocerus* Harris. *Rosa carolina* L.
62. *Rhodites globulus* Bent. *Rosa carolina* L.

Arachnida.

63. *Acarus serotinae* Bent. *Prunus serotina* Ehrh.

Nos. 52, 56 and 60 were sent to me by Mr. F. C. Senour, of New Augusta, Indiana. The others and also specimens of No. 52 were collected by me near Greencastle, Indiana.

We have now a list of sixty-three species, representing twenty-five genera and five orders of insects, including Arachnida. The host plants represent eleven orders, fourteen families and eighteen genera.

Tyloses in Brosimum Aubletii.

Katherine E. Golden.

The wood of Brosimum Aubletii has been given various common names, as leopard-wood, letter-wood, and snake-wood, on account of the mottled appearance of part of its heartwood. It is a very hard, compact wood, dark brown in color, and has part of the heartwood beautifully mottled with black. The mottling is due to the sclerenchymatous tyloses which fill its tracheæ.

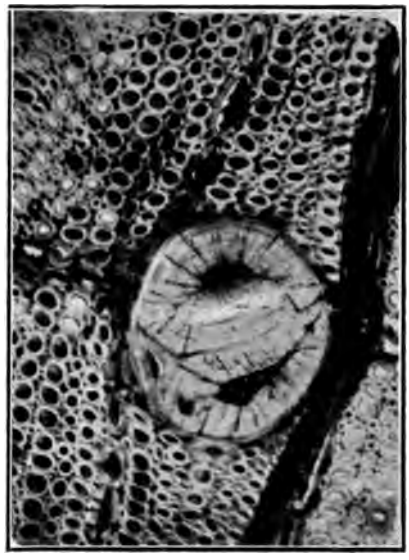
The wood is composed of a mass of fine fibres, nearly round in transverse section, and arranged in fairly regular radial rows. The fibres are flattened tangentially when adjoining either parenchyma cells or

Leopard-wood. Tang. Sect. (x 300)

tracheæ. The tracheæ are scattered promiscuously throughout the fibres, either singly or in groups of two to four. They are finely pitted, and consist of vessels and tracheides. Parenchyma occurs around the tracheæ, sometimes in single rows, sometimes irregularly grouped, also in tangen-

tial lines, and in regular radial rows, having blind ends, as they seem to start and to stop anywhere. The tangential rows branch, the branches running into other rows or joining with the cells around tracheæ. Sometimes the tangential and radial rows are so regular that they give the wood a cross-barred appearance.

The medullary rays consist of very narrow, long cells, the long diameter running in a radial direction. They are from one to four cells wide, the more common number being two. They are from about fifteen to fifty cells in height, though an accurate count could not be made, due to the presence in every ray of larger sclerenchymatous cells. One or more of these sclerenchymatous cells, having fairly thick walls, occur in



Leopard-wood. Trans. Sect. (x 300)

each ray, either at the end or throughout its height. In all cases a sclerenchyma cell occupies the place of two to four of the regular parenchyma cells and seems to be the result of the merging of a number of the parenchyma cells. They are seen to best advantage in the tangential section.

In a similar way the radial rows of parenchyma, though as regular in their formation as the rays, are easily distinguished from the rays by their greater size and sclerenchymatous walls.

All the elements of the wood, including even the wood fibres, have their lumina filled with a brown to black solid coloring matter. The walls of the elements are not impregnated with the color, and consequently stand out distinctly, so that their peculiarities are easily observed.

The chief peculiarity of Leopard-wood is the presence of sclerenchymatous tyloses. Thyloses or tyloses, as they are more commonly called, are ingrowths of parenchymatous cells into the cavity of the tracheæ. When a trachea is adjoined by parenchyma, the parenchyma retains its protoplasm after the trachea becomes empty; as the parenchyma exerts pressure on the non-resistent walls of the trachea, the parenchyma pushes into the cavity of the trachea through a pit or weak spot, forming a short

Leopard-wood. Trans. Sect. (x 80)

tube. The tube may be the only one at that part of the trachea, or there may be so many that there is a series of tubes lining the entire cavity. These ingrowths may make no further progress, but the more common method of development is the formation of a wall at the junction of the tracheal wall, cutting off the ingrowths. These ingrowths may then carry on cell division, forming a mass of parenchyma filling the lumen of the trachea. Tyloses form in many Dicotyledons as a regular phenom-

enon, and without the occurrence of any injury to stimulate growth. They form in pitted tracheæ usually, though in some one-year old stems they form in fibrously thickened tracheæ without any perforations.

The walls of the tyloses are delicate at first, but they afterwards thicken somewhat, and their cellulose walls become lignified like the rest of the wood parenchyma.

In Leopard-wood the tyloses have their walls so strongly thickened that the cells resemble the stone cells in pears. Nearly all the tracheæ are filled with them, rarely is there found a portion of a trachea without

Leopard-wood. Tang. Sect. (x 80)

them. The stone cells are irregular in shape, and are packed closely together, usually one being sufficient to fill the lumen transversely, though sometimes two and three are wedged together across the lumen. The walls vary considerably in thickness, some having their lumina entirely obliterated, while in close proximity to them may be others with fairly large lumina. In all of them the thickening of the walls is in well-defined layers, the layers sometimes separating from each other. All the walls are provided with fine canals, radiating from the central lumen, sometimes branched, and in all, the canals of adjoining cells corresponding.

The tyloses give the wood a characteristic appearance under the microscope. This can be seen in the photographs, though much of the beauty is lost with the loss of color.

Boulger (1) in his valuable work on wood mentions the sclerenchymatous tyloses of the Leopard-wood, and in describing the gross structure of the wood, states that the sapwood is yellow, and that the tree has heartwood squaring twenty inches, though only six inches show the characteristic mottling. This would seem to indicate that even if all the heartwood had tyloses form, not all become sclerenchymatous.

Leopard-wood. Rad. Sect. (x 80)

The wood is used in this country in the manufacture of musical instruments, and only the mottled wood is prized. Pieces of the mottled were all that I was able to obtain, so I had no way of determining anything in regard to the tyloses in the sapwood or unmottled heartwood.

The formation of tyloses through the activity of the parenchyma, can be readily understood, but nothing is known as to the cause of this activity in some woods, while in other woods tyloses are never formed. Then again in most woods investigated nothing definite as to time of formation is known. DeBary (2) states that in Robinia pseudacacia tyloses form in

the autumn in the wood formed the previous spring, and that this is true, also, of other woods, but nothing definite as to their occurrence or absence is known. Further investigation is necessary to determine the facts relative to tyloses other than their structure and seemingly haphazard occurrence.

1. Boulger, G. S. Wood, 1902.
2. DeBary, A. Comparative Anatomy, 1884.

Some Experiments with a Simple Jolly Balance.

Lynn B. McMullen.

In presenting a paper of this kind before the Academy of Science I think it is well to point out that the research work of the high school teacher must be "re"search work indeed—must be research work backward instead of forward. If I might be allowed to read you a parable I should remind you that some fifty, or perhaps sixty, years ago our grandfathers came to Indiana to do research work of a bread-winning character. But those grandparents had brothers, who, through necessity or lack of years, were compelled to stay at home and take care of the real little folks. I take it that the same thing is true of the members of this Academy. Some, usually those of the colleges, are able to do research work. Others, particularly those of the high schools, must expend their energies in the perfecting of details.

Those of us that remember our college course in Physics hold the old Jolly balance, with which we wrestled, in much awe. Certainly no piece of apparatus could be more perverse. The spring being stationary at the top and entirely free at the bottom would take its time in coming to rest and its distance from the meter stick gave parallax an excellent opportunity to do its worst. Further, as the spring stretched the table must be moved, and the table was usually stuck. It is easy to see *now* that the conversion of the Jolly balance from a rogue to a useful citizen depended upon some device for stretching the spring "up" from a stationary bottom instead of "down" from a stationary top. It is the purpose of this paper to explain one such device and to present data showing the accuracy that may be obtained by using it.

The base of the balance is a Sapolio box 6x9x12-in. mounted on leveling screws and weighted with a brick. To the front of the box is screwed an upright standard four feet long. This standard is made by nailing to the face of a piece of poplar ½x2-in. two strips ¼x½-in. leaving a groove between them 1-in. wide and ¼-in. deep in which a meter stick may slide freely. To the upper end of the meter stick is fastened a string which runs over a pulley at the top of the standard. The other end of this string is tied to the end of a large horizontal screw which runs through the side of the box with sufficient friction to hold the meter stick in any desired position. From the top of the meter stick at right angles to it

projects an arm two inches long to the end of which the spring is attached. From the lower end of the spring is suspended an indicator of the form shown in figure I, with the usual pans below. The shelf shown in figure I upon which the point of the indicator rests when not in use is made of sheet brass and is fastened to the column one foot from the lower end. Tacked to one of the side strips immediately below this shelf so that it projects over the meter stick slightly is a small metal plate

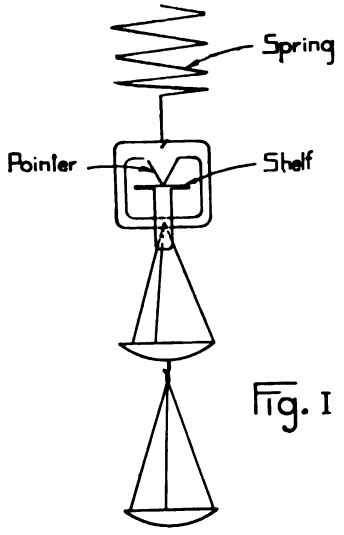


Fig. I

bearing a horizontal scratch. The distance from the top of the meter stick to this scratch can be read with considerable accuracy to the tenth part of a millimeter. Below this shelf slides a table upon which vessels of water, etc., can be placed. To use the apparatus the spring must first be calibrated. Incidentally, Hooke's law may be verified. To do this a reading of the distance from the top of the stick to the scratch is taken when the spring is so adjusted that the pointer barely swings clear of the shelf, no load being in the pans. A load of one gram is then added and the spring is stretched,—by raising the meter stick with the before mentioned cord and screw—until the pointer clears the platform again. The distance from the top of the meter stick to the scratch is again read. The difference between the two readings gives the elongation for a load of one gram. For ordinary work this elongation should be about five

centimeters. With such a spring it is seen that a load of .002 grams will cause an elongation of .1 of a millimeter.

The following tables of data and results obtained by using this simple Jolly balance are self explanatory. They are given not because of any new principle contained in them, but because of the extreme accuracy shown—accuracy seemingly out of all proportion to the care with which the apparatus was constructed.

HOOKE'S LAW AND THE MODULUS OF THE SPRING.

Load.	No Load Reading.	Reading with Load.	Elongation.	E/L.
1 g.	54.96 cm.	60.14 cm.	5.18 cm.	5.18
2	54.96	65.33	10.37	5.18(5)
3	54.96	70.51	15.55	5.18(8)
4	54.96	75.66	20.70	5.17(5)
5	55.00	80.90	25.90	5.18(0)
	Modulus = L/E = .193.		Mean	5.180

DENSITY OF A STEEL BICYCLE BALL.

No Load.	Load.	Elongation.
54.97 cm.	83.95 cm.	28.98 cm.
54.97	83.93	28.96
55.00	83.97	28.97

Mean elongation = 28.97.
Mass = elongation × modulus = 5.591 g.
Diameter by micrometer screw caliper = 1.1115 cm.
Volume .7189 cc.
Density = M/V = 7.78 g. per cc.

PRINCIPLE OF ARCHIMEDES.

Ball in Air.	Ball in Water.	Decrease.
82.98 cm.	79.32 cm.	3.66 cm.
82.99	79.30	3.69
83.00	79.34	3.66

Mean decrease in elongation = 3.67
Loss of weight in water .708 g.
Volume of ball from preceding experiment .718 cc.
Volume of water displaced by the ball .718 cc.
Weight of water displaced by the ball .718 g.

The weight of the water displaced by the ball differs from the loss of weight by 1.4 %. The accuracy may be increased by using aluminum instead of steel.

SPECIFIC GRAVITY OF AN IRREGULAR SOLID.

No Load.	Aluminum in Air.	Aluminum in Water.
54.07 cm.	88.36 cm.	75.70 cm.
54.07	88.38	75.69
54.08	88.38	75.69

Elongation in air 34.31 cm.
Elongation in water 21.62 cm.
Decrease in water 12.69 cm.
Specific gravity of aluminum 2.70.

SPECIFIC GRAVITY OF SOLIDS LIGHTER THAN WATER.

No Load.	Paraffin in Air.	Paraffin and Aluminum in Water.
54.01	67.23	73.39
54.01	67.25	73.37
54.00	67.24	73.38

Elongation due to paraffin in air 13.23 cm.
Elongation due to both in water 19.37 cm.
Elongation due to aluminum in water 21.61 cm.
Elongation due to paraffin in water —2.25 cm.
Loss by paraffin in water 15.48 cm.
Specific gravity of paraffin = .854.

SPECIFIC GRAVITY OF LIQUIDS.

No Load in Ether.	Aluminum in Ether.
54.26 cm.	79.01 cm.
54.26	79.00
54.27	79.00

Elongation due to aluminum in air 34.31 cm.
Elongation due to aluminum in ether 24.74 cm.
Decrease in ether 9.57 cm.
Decrease in water 12.69 cm.
Specific gravity of ether .754.

Besides these, two other experiments can be performed in a very satisfactory manner, namely, "The Surface Tension of Water" and "The Distribution of Magnetism in a Bar Magnet."

Newtonian Idea of the Calculus.

Arthur S. Hathaway.

The history of the calculus shows that even a mathematical theory cannot escape the effects of environment. Sir Isaac Newton was for many years the sole possessor of a knowledge of the calculus, and used it with a power which few have been able to equal since his time; yet he has had practically no influence on its present form of development. This was due to Newton's dislike for controversy, so that instead of contending for his ideas, he let them appear only in concise and general form, or even not at all. With the exception of his first two papers on optics, "all of his works were published only after the most persistent solicitations of his friends, and against his own wishes." The criticism which would have aroused an ambitious man to a vigorous defense, had the opposite effect on his disposition. "I was so persecuted," he wrote, "with discussions arising out of my theory of light, that I blamed my own imprudence for parting with so substantial a blessing as my quiet to run after a shadow."

Newton was well versed in the method of fluxions, and the inverse method, that is in differentiation and integration, by the year 1666. In 1669 he circulated a manuscript on the subject among his friends, but refused their solicitations to have it published, and it was not until 1693 that it was communicated to the scientific world by Wallis, in the second volume of his works. During this interval of a quarter of a century, Newton had changed his ideas in important respects, through extensive use of the calculus. He had developed his Theory of Light, discovered the Binomial Theorem, determined the Law of Gravitation, and the Principles of Dynamics, and made important investigations in all departments of mathematical and physical science.

Although the *Principia*, which appeared in 1687, contained no direct information on the calculus, yet its fundamental ideas and principles were involved in every detail of the work. The development of the *Principia* is due to the calculus, but Newton undertook the laborious task of translating everything into the elementary geometrical methods of the time and omitted many results which he had obtained by the calculus, because he could not so interpret them. Many things have been discovered since his time that were afterwards found in his papers

and correspondence, and he left many undemonstrated theorems, whose proofs baffled succeeding mathematicians for 50, 100, and even 200 years.

The *Quadrature of Curves*, published in 1704, and the *Principia*, are the proper sources for Newton's matured ideas on the calculus, and not his earlier manuscript, published by Wallis. The earlier paper adopts the infinitesimal method of neglecting small quantities which is now associated with Leibnitz's calculus, not, however, with the latter's disregard of logic, but in connection with the idea of a limit which is the modern foundation of that method.

Newton states in the *Quadrature of Curves* that "in mathematics the minutest errors are not to be neglected." Also,

"I consider mathematical quantities in this place, not as consisting of very small parts, but as described by continuous motion. Lines are described and thereby generated, not by the apposition of parts, but by the continued motion of points; superficies by the motion of lines; solids by the motion of superficies; angles by the rotation of sides; portions of time by continual flux; and so on in other quantities. These geneses really take place in the nature of things and are daily seen in the motion of bodies."

He then goes on to define fluxions, or as we would now call them, differentials:

"Fluxions are as near as we please, as the increments of fluents, generated in times which are the same and as small as possible, and to speak accurately, they are in the prime ratio of nascent increments; yet they can be expressed by any lines whatever which are proportional to them."

Newton immediately illustrates this definition by the abscissa and ordinate of a curve, whose differentials are shown to be any corresponding increments of abscissa and ordinate along the tangent line. This, and numerous similar illustrations in the *Principia*, show that Newton meant by the ultimate ratio of vanishing quantities, *the limit of the ratio of any finite proportionals to the vanishing quantities*. See, for example, Princ. Bk. 1, Lemma 1, Art. 12, "Ultimate Ratio of Vanishing Quantities." Also, Lemmas 7, 8, 9. Newton did not consider the modern question as to whether or not this ratio was definite, and the answer to that question *is not pertinent to his definition*. In other words, differentials can exist when such ratio is indeterminate. Translated into its exact modern equivalent, his definition is:

Corresponding differentials are, as near as we please, proportionals to corresponding and indefinitely small increments of variables, and to speak accurately, they are corresponding limits of such proportionals.

The power and generality of this definition can only be understood after a careful study of its consequences. It applies whatever the number of independent variables. It is the mathematical foundation of Newton's conception of the state of change of variables, in which corresponding differentials are made to signify corresponding increments. In other words, corresponding increments of *a state of change of variables* are as near as we please, proportionals to corresponding and indefinitely small increments of the variables.

As an illustration of the method, consider $z=xy$, and as usual, let $\triangle x$, $\triangle y$, $\triangle z$, denote any corresponding increments of x, y, z. Then, $\triangle z=x\triangle y+y\triangle x+\triangle x\cdot\triangle y$

Let N be a variable number which becomes indefinitely large in any way whatever (as $N=1, 2, 3, 4$, and so on indefinitely). Conceive $\triangle x$, $\triangle y$, to diminish as N increases, so that their proportionals, $N\triangle x$, $N\triangle y$, remain finite and approach limits designated by dx, dy ($\triangle x=dx/N+8'/N^2$, $\triangle y=dy/N+5/N^2$, for example). Then if dz denote the limit of the remaining proportional $N\triangle z$, the equation from which it is to be determined is $N\triangle z=xN\triangle y+yN\triangle x+N\triangle x\cdot\triangle y$, which gives, by the theorems of limit, $dz=xdy+ydx$.

Here, the ratio dz/dx is absolutely indeterminate, since it depends upon the values chosen for dx, dy.

Leibnitz rediscovered the calculus in 1676, and immediately published his methods and spread them over Europe. His right to the title of independent discoverer was disputed by the friends of Newton, because when Leibnitz was just turning his attention to mathematics in 1673, he visited London and consulted some manuscripts of Newton. Leibnitz's defense is that he did not see the manuscript on the calculus, and his notes taken at the time, and afterwards discovered, contain only references to Newton's papers on optics. It is fortunate in respect to notation that we have received the calculus from the hands of Leibnitz rather than Newton; but the history of the calculus, from Leibnitz on, revolves about objections to his infinitesimal methods. In order to avoid those methods, Lagrange recast the calculus into practically its present form. He regarded the differentials of the independent variables as their small actual increments, and the differential of a dependent variable as that part of its increment which is of first degree when it is expanded in ascending powers of the

independent increments. In his method, the principle quantities were the differential coefficients, and if z were a function of x, y, he wrote

$$dz = \frac{dz}{dx}\,dx + \frac{dz}{dy}\,dy$$

where dz/dx was a whole symbol for the coefficient of dx in dz, and not the quotient of dz by dx; and similarly for dz/dy.

This idea was not received with favor, partly because it made the calculus depend upon expansions in series, whereas, one important feature of the calculus was the determination of such expansions.

At present, we have a derivative calculus, with a differential notation, in which differentials have significance only in quotient forms; in fact the derivative is Lagrange's differential coefficient, and the two terms are used interchangeably. The student is taught that the quotient form is an inseparable symbol, but the notation, and the calculus itself, eventually require their separation. The explanations which have been devised for such separation of inseparable symbols are sometimes remarkable. The method of rates is simply to define the derivative dy/dx as the rate at which y is changing, and dy, dx, as any quantities whose ratio is dy/dx. This is not the same as Newton's method, who makes dy the amount which y changes in its state of change when x changes by dx, and thence dy/dx is the change of y per unit change of x. It *does* matter whether we make differentials the prime quantities, and thence deduce the significance of their ratios, or whether we make the ratios the prime quantities, and thence deduce differentials. For, two variables can have differentials, with no ratio that is *definite*, i. e., independent of the values of the differentials themselves.

In a calculus in which the derivative is the prime quantity, the differential notation creates numerous *artificial* difficulties which would be eliminated by a proper derivative notation; but this would limit the scope of the calculus and alter many of its time-honored developments. Nor is it necessary to make a change of notation, because the present notation is made completely significant by Newton's definition.

When we consider the weight that attaches to the name of Newton, it would seem that his views on the calculus were worthy of being considered, even today. When we add that he is the original inventor, and that his fundamental idea of the differential is the very one that is needed to give the differential calculus an intelligent and rigorous mathematical basis, it is certainly time that he came into his own.

Conditions for the Deformation of Surfaces Referred to a Conjugate System of Lines.

Burke Smith.

When a surface is subjected to a series of deformations, each form that it assumes during the deformation may be thought of as a separate, distinct surface. We may thus regard a deformation of a surface as a continuous system of surfaces, each representing some form into which the original surface may be deformed. In this paper we consider the problem of determining those surfaces which may be deformed so that a conjugate system of lines will still remain a conjugate system after the deformation is carried out.

We shall suppose that the equations of the surfaces that we consider are given in the form,

$$x = f_1(\mu, \nu), \qquad y = f_2(\mu, \nu), \qquad z = f_3(\mu, \nu),$$

and that the first and second fundamental magnitudes are E, F, G and D, D′, D″, respectively.

If S_2 represents the form that S_1 takes when deformed so that a conjugate system remains a conjugate system, then S_2 is applicable on S_1. But the necessary and sufficient condition that two surfaces should be applicable on each other is that they shall have the same lineal element and the same total curvature.

If the parametric lines, $\mu = \text{const.}$, $\nu = \text{const.}$, on S_1 and S_2 form a conjugate system, then $D' = o$ for both S_1 and S_2. Since S_1 and S_2 must have the same lineal element and the same curvature, we have from the relation,

$$K = \frac{D\,D''}{EG - F^2}$$

that $D_2 = \lambda D_1$ and $D_2'' = \lambda D_1''$ where the subscripts refer to S_1 and S_2 respectively, and λ is a function of μ and ν. To determine λ we make use of the fact that Codazzi's equations must be satisfied for both S_1 and S_2. Bianchi* has thus shown that λ must satisfy the equations,

$$\frac{\delta}{\delta\mu}\left(\frac{1}{\lambda}\right) = -\left\{\begin{matrix}12\\2\end{matrix}\right\}'\left(\frac{1}{\lambda} - \lambda\right)$$

*" Vorlesungen über Differential-Geometrie," p. 336.

(1)
$$\frac{\delta}{\delta v}(\lambda) = -\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}' \left(\lambda - \frac{1}{\lambda}\right)$$

where $\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'$ and $\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}'$ are the symbols of Christoffel formed with respect to the Gauss sphere. Since now $\frac{\delta^2\lambda}{\delta\mu\,\delta v} = \frac{\delta^2\lambda}{\delta v\,\delta\mu}$ we have from (1), as the condition of integrability,

(2) $$\lambda^2\left[\frac{\delta}{\delta v}\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}' - 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}'\right] = \left[\frac{\delta}{\delta\mu}\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}' - 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}'\right]$$

Having given the surface S_1, then to every value of λ which satisfies (1) and (2) there corresponds a surface S_2 of the desired type.

There are three possible cases that may occur under (2). Suppose, first, that the surface S_1 is such that

(I) $$\frac{\delta}{\delta v}\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}' = 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}' = \frac{\delta}{\delta\mu}\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}'$$

In this case the condition of integrability (2) is satisfied for every value of λ, and since equations (1) are of the first order, there are in this case ∞^1 surfaces S_2 which are applicable on S_1 and such that their parametric lines form a conjugate system. We thus have in this case a continuous system of surfaces, and the above equations are the necessary and sufficient condition that a surface may belong to such a system.

Suppose, next, that S_1 is such that

(II)
$$\frac{\delta}{\delta v}\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}' = 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}' \qquad \frac{\delta}{\delta v}\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}' \neq 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}'$$

or,

$$\frac{\delta}{\delta\mu}\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}' \neq 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}' \qquad \frac{\delta}{\delta\mu}\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}' = 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}'$$

In this case λ vanishes or is undefined, and the condition of integrability is not satisfied. Consequently there exists no surface S_2 in this case.

Suppose, finally, that

(III)
$$\frac{\delta}{\delta v}\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}' \neq 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}'$$

$$\frac{\delta}{\delta u}\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}' \neq 2\begin{Bmatrix} 12 \\ 1 \end{Bmatrix}'\begin{Bmatrix} 12 \\ 2 \end{Bmatrix}'$$

We have in this case one, and only one, value for λ^2. If the surface S_1 is such that in addition to (III) being satisfied, (1) are also satisfied, then

there is one, and only one, surface S_2 which represents the result of deforming S_1 so that a conjugate system remains a conjugate system after the deformation.

There are two cases which may occur under (III). Suppose that

$$(\mathrm{III_a}) \qquad \frac{\delta}{\delta v}\begin{Bmatrix}12\\2\end{Bmatrix}' = \frac{\delta}{\delta \mu}\begin{Bmatrix}12\\1\end{Bmatrix}'$$

Then $\lambda = \pm 1$ and the surface S_2 is such that its second fundamental magnitudes D_2 and D_2'' are either equal to the corresponding magnitudes D_1 and D_1'' of S_1 or they are the negatives of D_1 and D_1''.

But from the equations (*)

$$\frac{\delta x}{\delta \mu} = \frac{D}{eg - f^2}\left(-g\frac{\delta X}{\delta \mu} + f\frac{\delta X}{\delta v}\right)$$

$$\frac{\delta x}{\delta v} = \frac{D''}{eg - f^2}\left(f\frac{\delta X}{\delta \mu} - e\frac{\delta X}{\delta v}\right)$$

Where e, f, g are the fundamental magnitudes of the Gauss' sphere, it is seen that a change in the sign of D and D'' corresponds to a change of sign in the co-ordinates x, y, z of the surface, and therefore the surface S_2 is either identical with S_1 or it is symmetrical to S_1 with respect to a plane or to the origin of co-ordinates.

Suppose next that

$$(\mathrm{III_b}) \qquad \frac{\delta}{\delta v}\begin{Bmatrix}12\\2\end{Bmatrix}' \neq \frac{\delta}{\delta \mu}\begin{Bmatrix}12\\1\end{Bmatrix}'$$

In this case there is a unique value of $\lambda^2 \neq 1$. S_1 may therefore be deformed so that after the deformation is carried out the lines $\mu = \text{const.}$, $v = \text{const.}$, form a conjugate system, although they do not form a conjugate system at any time during the deformation. Now, by a theorem of Dini, (**) from relation ($\mathrm{III_b}$) no surface S_0 exists, the spherical images of whose asymptotic lines are the same as the spherical images of a conjugate system of lines on S_1. But from the definition of associate surfaces, there is then no surface to which S_1 is associated, and thus we have the result that when ($\mathrm{III_b}$) is true for any surface S_1 referred to a conjugate system, there exists no surface S_0 to which S_1 is associated.

(*) Bianchi, l. c. p. 134.
(**) Bianchi, l. c. p. 125.

A Family of Warped Surfaces.

C. A. Waldo.

Derivation of the general equation of all warped surfaces having two distinct rectilinear directrices and its application to a few special cases.

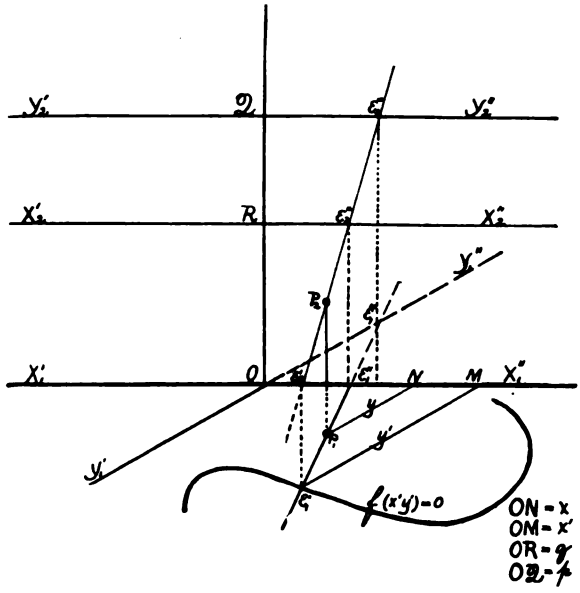


Fig. 1.

Let the surface be defined by the three directrices

$$x = O, \ldots\ldots z = p,$$
$$y = O, \ldots\ldots z = q,$$
$$f(x'y') = O, \ldots\ldots z = O.$$

The curve $f(x'y') = O$ lies in the plane $z = O$, the X and Y axes are parallel to the rectilinear directrices; the Z axis includes the common perpendicular to the rectilinear directrices, unless otherwise specified.

In the diagram Fig. 1, let $X'X''$ be one straight line directrix at the distance q above the plane $z = o$, $Y'Y''$ the other at p above $z = o$. Their horizontal projections will be the X and Y axes of reference.

Let (x, y, z) be any point P on the warped surface, and E′ E″ E‴ the rectilinear element containing it.

Let O M = x′ , O N = x , O R = q, O Q = p.

Then by similarities and projections the following equations exist:

$$\frac{x'}{x} = \frac{E'''_1 E'_1}{E'''_1 P_1} = \frac{E'''_2 E'_2}{E'''_2 P_2} = \frac{p}{p-z}, \quad x' = \frac{p x}{p-z}$$

Similarly, $$y' = \frac{q y}{q-z}$$

Substituting these values of x′ y′ in f (x′ y′) = o, there results the corresponding functional equation,

$$f\left(\frac{p x}{p-z}, \frac{q y}{q-z}\right) = o,$$

which is the equation in Cartesian co-ordinates X, Y axes general, Z axis perpendicular to X and Y of the warped surfaces as defined above and includes *every* warped surface with two distinct rectilinear directrices. For its application it requires that a section of the surface should be known parallel to the right-line directrices and not including either of them. This general surface is referred directly to the orthogonal projections of two warped lines in space upon a plane parallel to both, and to their common perpendicular. The angle at which the lines intersect is implicitly contained in the equation of the surface. The form of the equation of the surface does not change, therefore, when the surface itself is deformed by changing the angle in space of the right line directrices, provided the form of the equation of the plane curve directrix remains unchanged.

It is also at once evident that the method derives immediately the Cartesian equation of the warped surface determined by the fact that an element cuts a curved directrix, a linear directrix and is parallel to a given plane. This is equivalent to saying that one of our parameters p, q, remains finite while the other becomes indefinitely great.

For simplicity suppose the three axes always at right angles to each other unless otherwise specified.

The Hyperbolic Paraboloid.

(a) Let f (x′ y′) = x′ − y′ = O.

Then $f\left(\frac{p x}{p-z}, \frac{q x}{q-z}\right) = \frac{p x}{p-z} - \frac{q y}{q-z} = o.$

Let p = 1, q = −1

Then x + xz − y + yz = o.

Rotate the xy axes through $\pi/4$, then the zx axes in the same way, and there results the well known equation,

$$x^2 - z^2 = 2y.$$

(b) Let $f(x'\,y') = x'\,y' - c = o.$

Then $f\left\{\frac{p\,x}{p-z}, \frac{q\,y}{p-z}\right\} = \frac{p\,x}{p-z}\,\frac{q\,y}{q-z} - c = \frac{p\,x}{p-z}\,\frac{y}{1-\frac{z}{q}} - c = o.$

Let $p = 1$ and q become indefinitely great,

Then $xy = c\,(1-z).$

Rotate the zy axes through $\pi/4$, let $c = 1$ and

$1 - z = Z,$

Then $x^2 - y^2 = 2Z.$

Compare this operation and result with the next.

THE HYPERBOLOID OF ONE SHEET.

Let $f(x'\,y') = x'\,y' - c = o$

as above $\frac{p\,x}{p-z}\,\frac{q\,y}{q-z} = c.$

let $p = 1,\ q = -1$

Then $xy = c\,(1 - z^2).$

Rotate xy axes through $\pi/4$, let $c = 1/2.$

Then $x^2 - y^2 + z^2 = 1.$

A CUBIC SURFACE WITH PARABOLIC SECTIONS.

Let $f(x'\,y') = y'^2 - x' = o.$

Then $f\left\{\frac{p\,x}{p-z}, \frac{q\,y}{q-z}\right\} = \frac{q^2\,y^2}{(q-z)^2} - \frac{p\,x}{p-z} = o.$

a. Let $p = 1$ and $q = -1.$ Then

$y^2\,(1-z) = x\,(1+z)^2$, one of the cubical warped surfaces.

b. Let $p = 1,\ q = \infty$, then $y^2\,(1-z) = x.$

c. Let $q = 1,\ p = \infty$, then $y^2 = x\,(1-z)^2.$

BIQUADRATIC SURFACE WITH HYPERBOLIC SECTIONS.

Let $f(x'\,y') = x'^2 - y'^2 - c = o$

Then $f\left\{\frac{px}{p-z}, \frac{qy}{q-z}\right\} = \frac{p^2x^2}{(p-z)^2} - \frac{q^2y^2}{(q-z)^2} - c = o$

a. Let $p = 1,\ q = -1,\ c = 1$

Then $x^2\,(1+z)^2 - y^2\,(1-z)^2 = (1-z^2)^2$

b. Let $p = 1$, $q = \infty$, $c = 1$
Then $x^2 - y^2 (1 - z)^2 = (1 - z)^2$

c. Let $p = \infty$, $q = 1$, $c = 1$
Then $x^2 (1 - z)^2 - y^2 = (1 - z)^2$

BIQUADRATIC SURFACE WITH ELLIPTICAL SECTIONS.

Let $f(x' y') = x'^2 + y'^2 - c = o$

Then $f\left\{\frac{px}{p-z}, \frac{qy}{q-z}\right\} = \frac{p^2 x^2}{(p-z)^2} + \frac{q^2 y^2}{(q-z)^2} - c = o$

a. Let $p = 1$, $q = -1$, $c = 1$
Then $x^2 (1 + x)^2 + y^2 (1 - z)^2 = (1 - z^2)^2$

Here the volume between rectilinear directrices is exactly that of a sphere of radius one.

b. Let $p = aq$, $c = 1$

Then $$\frac{x^2}{\left(1 - \frac{z}{aq}\right)^2} + \frac{y^2}{\left(1 - \frac{z}{q}\right)^2} = 1.$$

Circular sections are at $z = o$ and $z = \frac{2aq}{1+a}$.

The planes $z = o$, $z = q$, $z = \frac{2aq}{1+a}$, $z = aq$ divide every transversal harmonically. In particular every element is divided harmonically by the circular sections and the rectilinear directrices.

c. Combining the last two surfaces and letting $p = aq$,

$$\frac{x^2}{\left(1 - \frac{z}{aq}\right)^2} \pm \frac{y^2}{\left(1 - \frac{z}{q}\right)^2} = 0$$

Solve for sections parallel to the xy plane and of the same eccentricity:

$m\left(1 - \frac{z}{aq}\right) \pm \left(1 - \frac{z}{q}\right)$ which gives

$z = \frac{aq(m-1)}{m-a}$ and $z = \frac{aq(m+1)}{m+a}$ for similar conic sections.

It is then easily seen that the four planes,

$z = q$,

$z = \frac{aq(m-1)}{m-a}$

$z = aq$,

$z = \frac{aq(m+1)}{m+a}$,

divide any transversal harmonically.

d. In the most general form with elliptic sections:

Let $p = 1$, $q = \infty$, $c = 1$.

Then $x^2 + (1 - z)^2 y^2 = (1 - z)^2$, the equation of Wallis's Conoeo-Cuneus, or the ship carpenter's wedge.

e. Assume case a. The central section at $z = o$ is a circle. Deform the surface by rotating one directrix about the Z axis any angle less than $\pi/2$. The section $z = o$ will now be an ellipse referred to its equi conjugate diameters. The form of the equation of this section will not change; also the form of the equation of the deformed surface will be invariant.

Order of the Resulting Warped Surfaces.

Let $f_n(x\ y)$ represent a homogenous algebraic expression involving x and y and of the nth degree.

In the fundamental demonstration,

1. Let $f(x'\ y') = f_1(x\ y) - c = o$.

   If x and y are both present, the corresponding warped surface is of the 2d order.

   If x or y is absent, the resulting surface is a plane.

2. Let $f(x'\ y') = f_2(x\ y) + f_1(x\ y) - c = o$.

   x^2 and y^2 both present, 4th order.

   x^2 or y^2 absent, other terms present, 3d order.

   x^2 and y^2 both absent, xy present, x and y present or one or both absent, 2d order.

3. Let $f(x'\ y') = f_3(x\ y) + f_2(x\ y) + f_1(x\ y) - c = o$.

   x^3 and y^3 both present, 6th order.

   x^3 or y^3 absent, other terms present, 5th order.

   x^3 and terms involving x^2 absent; or, y^3 and terms involving y^2 absent, 4th order,

   x^3 and y^3 both absent, other terms present, 4th order.

   x^3, y^3, and xy^2 and terms involving y^2 absent, other terms present; or, x^3, y^3, and x^2y and terms involving x^2 absent, other terms present, 3d order.

To deduce the general law of order of the resulting scrolls, construct Fig. 2. Within the squares are present all the powers and combinations that can occur in a complete equation in x, y, of the 5th degree. The numbers at the intersections of the lines show the order of the resulting scroll provided at least two terms remain in our original $f(x', y') = o$, one

of which lies in a square two sides of which converge in the angle in question, or one of the two terms lies in a square bounded above and to the right by one of the lines converging at the angle, the other in a square

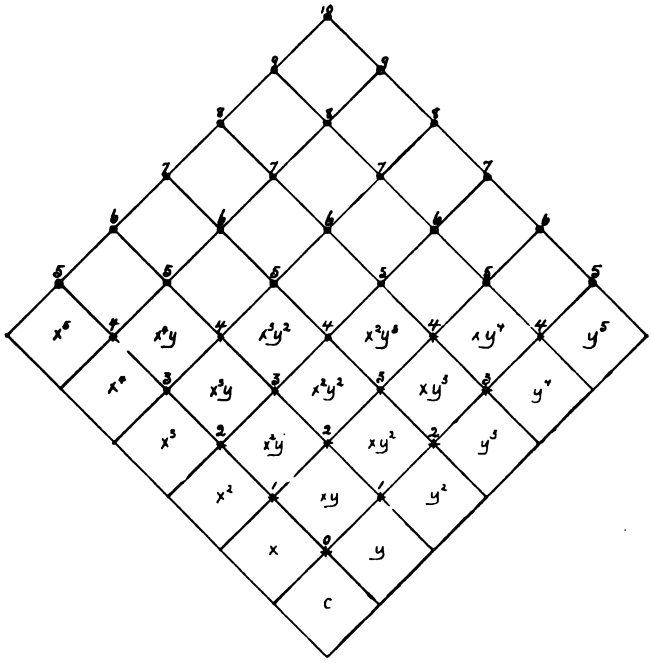


Fig. 2.

bounded above and to the left by the other line making the angle. Thus below one of the points marked 5 is found the term x^3y^2. This term joined with any or all others lying between the lines converging at that particular 5, will yield a scroll of the 5th order.

So also we will have a scroll of the 5th order if we select x^2y^2 on one side and x^3 on the other side of the space bounded by the lines converging at the same point 5.

At the middle point of the whole of Fig. 2 is a vertex marked 4. The following groups can be arranged for the equation of the curvilinear directrix, but in every case the resulting scroll will be of the 4th order.

1. x^2y^2 and c present, xy present or absent,
2. x^2y^2 and c present, and other terms present besides x y,

3. x^2y and xy^2 present, other terms present or absent,

4. x^2y and y^2 present, other terms present or absent (or xy^2 and x^2),

5. x^2 and y^2 present, other terms of lower degree present or absent.

1 and 2 are built from 4th degree terms and the resulting equation is only the 4th.

3, has two 3d degree terms present, scroll 4th.

4, one term 3d degree, other 2d, scroll 4th.

5, built from second degree terms, scroll 4th.

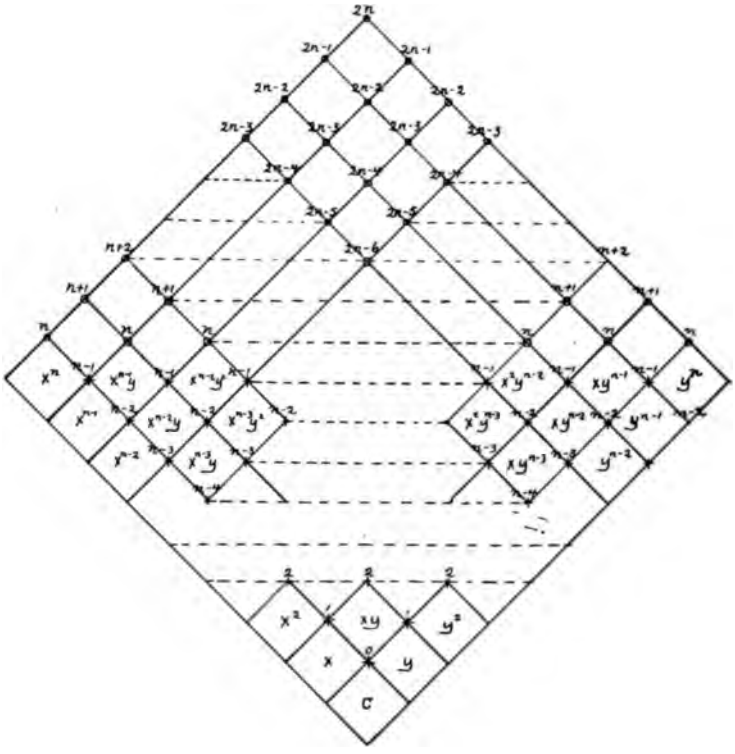


Fig. 3.

Fig. 3, shows at once the order of the resulting scroll when the equation of the curvilinear directrix is marked by the presence or absence of certain specified terms.

Double Generation.

The law of double generation is simply stated. Two straight lines are chosen parallel to the plane of the curvilinear directrix, the three giving rise to a scroll of a certain equation. Suppose two other straight lines can now be found parallel to the plane of the curvilinear directrix and intersecting the first two rectilinear directrices. Suppose the use of the second pair of lines gives exactly the same equation as the first two, then the surface is one of double generation. For example, $x'\,y' = c$. Substitute $\frac{px}{p-z}$ for x' making $p = 1$ and $\frac{qy}{q-z}$ for y' making $q = -1$. There results $\frac{xy}{(1+z)(1-z)} = c$; now make $p = -1$ and $q = +1$. The same equation results. In fact these are the two generations of the hyperboloid of one sheet.

It then becomes at once apparent that all scrolls are doubly generated whose curvilinear directrix has for its equation a function of the product term (xy), the plane of the curvilinear directrix being parallel to the rectilinear directrices. Thus the first of the five 4th scrolls order mentioned above, viz.: the one having x^2y^2 and c, and perhaps x y terms in the equation of the curvilinear directrix is a scoll of double generation.

It is not at once evident that the property discussed above is coextensive with all the doubly generated warped surfaces in the family under discussion. Such surfaces may also depend upon other properties not yet discovered.

General Observations.

It is evident that the validity of the demonstration does not require the axis of Z to be the common perpendicular between the two rectilinear directrices. If the Z axis connects the two directrices in question and passes through the middle point of their common perpendicular, it follows at once that the demonstration proceeds as before by parallel instead of orthogonal projection.

If we conceive the three axes of reference, under the restrictions just given, to be oblique to each other, we find the resulting equations are still in their simplest forms. In the surfaces of the second order the axes would then be conjugate axes. In surfaces of higher order the axes of reference would play the part of conjugate axes.

It will frequently happen that the equation of a scroll will be sought whose three directrices are given as above, viz., two rectilinear and one plane curvilinear directrix, but the latter in some plane not parallel to the two former lines.

In this case additional means should be given for writing the equation of the surface under the new conditions. It will then be easy to find a section parallel to the two right-line directrices and the problem then is solved by the process discussed in this paper.

A modification of the method here discussed finds the equation of a scroll given by two rectilinear directrices and a plane section of the surface, the section being oblique to a plane parallel to the two given straight lines

An Investigation of N-Rays.

R. R. Ramsey and W. P. Haseman.

This paper is an account of an attempt of the authors to repeat the experiments of R. Blondlot in which he has discovered that there is an invisible radiation given off from an Auer (Welsbach) burner, Nernst lamp and other sources.

Blondlot was investigating the polarization of X-rays (Comptes Rendus, Feb. 23, 1903) and using a feeble spark gap as a detector. He thought he had discovered that the X-rays were polarized in certain planes. In a few days (Comptes Rendus, March 23, 1903) he was convinced that the effects were due to other rays than X-rays. In May of the same year (Comptes Rendus, May 11, 1903) an article by Blondlot appeared, entitled, "Rays from an Auer Burner." An ordinary Welsbach burner (Auer burner) was surrounded with an iron chimney in which a window was cut and closed with an aluminum sheet .1 mm. thick. The radiation from this window was allowed to fall on the little spark gap and the intensity of the light from the spark was seen to increase. By means of a quartz lens Blondlot was able to detect four different wave lengths. The intensity of the spark gap is found to have four maximums as it is moved to and fro along the principal axis of the lens.

A week later (Comptes Rendus, May 25, 1903) Blondlot published an article in which he gave a list of various sources of N-rays and several means of detecting them, the chief ways being the little spark gap; a sheet of silver heated to a very dull redness by a little gas flame; a small phosphorescent screen which has been feebly excited by sunlight or other source.

The intensity or brilliancy of these detectors was found to increase when the radiation falls upon them. In this article Blondlot calls the new rays N-rays, from the town of Nancy, his home.

In a short time afterward Blondlot published an article in which he found that a Nernst lamp with an aluminum window is a good source. He also found that certain substances store up N-rays when they are exposed to N-rays and give off the rays afterward. Among those that store up the rays are quartz, stones and brick. Wood, aluminum, paper,

dry or wet, and paraffin do not store up the rays. He found that one of the essential conditions of a substance that stores up the rays is dryness. It is found that bricks exposed to sunlight become a source for hours afterward.

While experimenting along this line Blondlot discovered an unexpected effect. While viewing a strip of white paper which was feebly illuminated, a brick which had been exposed to sunlight was brought near the eye and the outline of the paper became more distinct. The intensity diminished when the brick was removed. A clock face which seemed a grey patch on the wall became clearly outlined and the hands visible when a brick was brought near the eye. Water intercepts the radiation, in fact, Blondlot used dampened paper as screens in his work. Salt water transmits the rays. An ox eye was transparent and became a secondary source. Hyposulphite of soda in solid or solution is found to be a powerful accumulator. Blondlot has found that compressed glass, wood, etc., emit N-rays and cause the phosphorescent screen to become more luminous. A bent cane near the head caused a clock to become more visible. Unbending the cane caused the clock to disappear. Tempered objects, such as files, knife blades, hammered brass, had the same effect, as also did a knife blade from an ancient tomb. The rays are emitted from nearly every strained object. In fact F. E. Hackett (Roy. Dublin Soc. Trans. 8, 10, pp. 127-138, Sept. 1904), the only English speaking person who is sure he has observed the effect, recommends the use of cork or wood under pressure as a source.

In the early part of the present year Blondlot finds that he has been dealing with two distinct kinds of radiation. N-rays cause the calcium sulphide screen to become more luminous, while the second radiation, or N_1-rays cause the normal intensity to decrease. N-rays cause the normal intensity from the screen to increase, while N_1-rays cause the tangential radiation of the screen to become more luminous.

Photographs have been published which show a greater effect on the plate under the influence of the N-rays than that without. For these photographs, in every case, the light from the little spark gap is used. A. Charpentier has found that the human body is a source of N-rays, the intensity being greater near the nerve centers. The spinal column can be traced by means of the screen. Certain parts of the brain give off the rays abundantly. The intensity being greatly augmented when the brain is active. Charpentier can see himself think. To refute those who

say the phenomenon is one of heat Charpentier has placed frogs on ice and lowered their temperature below that of the screen and shown that the cold frog is still a source.

Charpentier describes experiments in which N-rays are conducted along wire. Two phosphorescent screens are attached on the ends of a wire, length in one case 300 cm. N radiation is allowed to fall on one screen and the screen on the other end is seen to become more luminous. The N-rays are found by Charpentier to have the property of increasing the intensity of certain odors: ammonia, acetic acid, etc.

E. Meyer has found that plants emit N-rays. Certain substances while going into solution become sources. The electrolyte of a Le Clanche cell has been found to be a strong source after the cell has been short-circuited.

One curious fact about N-rays is that up to very recently at least, every successful experimenter has been a Frenchman.

Numerous short articles have appeared explaining the phenomena as one of heat or as one due to psychical phenomena.

Although we so far, like many others, have not been successful, we thought an account of our attempts was worthy of mention.

It was evident after a number of preliminary trials that the eye could not be relied upon to detect the variation in a feebly luminous source of light. The rays are produced by a Welsbach burner shut up in an iron pipe about 50 cm. long, 10 cm. in diameter with walls 1 cm. thick. The pipe is pierced by a window about 5 cm. long and 2 cm. in width

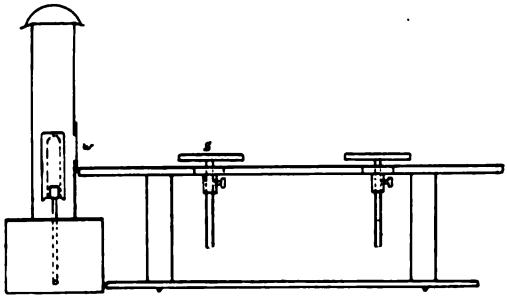


FIG. 1

and closed by some black paper, and a sheet of aluminum 16 mm. thick. The general arrangement of the apparatus is that shown in Fig. I. The

rays are supposed to pass through the window *W* and fall on some feebly luminous object such as a heated platinum wire or a calcium sulphide screen at *S*. Both the platinum wire and the sulphide screen were used and when viewed by the eye through ground glass at various angles and positions relative to the source nothing definite was noticed. The feebly luminous spot at times apparently brightened, then moved around in a circle and went through a series of displacements. This proved that nothing definite can be arrived at by viewing directly with the eye.

The most reliable method of recording the action of a feebly luminous source is photography. With this method, direct and indirect vision is eliminated, as well as the error due to the increased sensitiveness of the eye after being in the dark for some time. A number of photographs were taken, on Seed's regular "gilt edge" plates, with the light from a heated platinum wire, a luminous calcium sulphide screen, and a feeble spark.

The Platinum Wire.

The platinum wire was a very thin strip cut from a piece of foil .03 mm. thick, so that in no place was the wire more than .05 mm. broad. Only one place along it was allowed to be heated and the approximate breadth of this place was .03 mm. The wire was heated by a current approximately .9 amperes from three or five Edison-Lalande batteries. In some of the latter experiments a storage battery was used. The relative position of the different parts of the apparatus is shown in Fig. II.

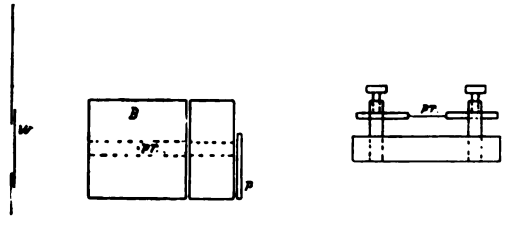
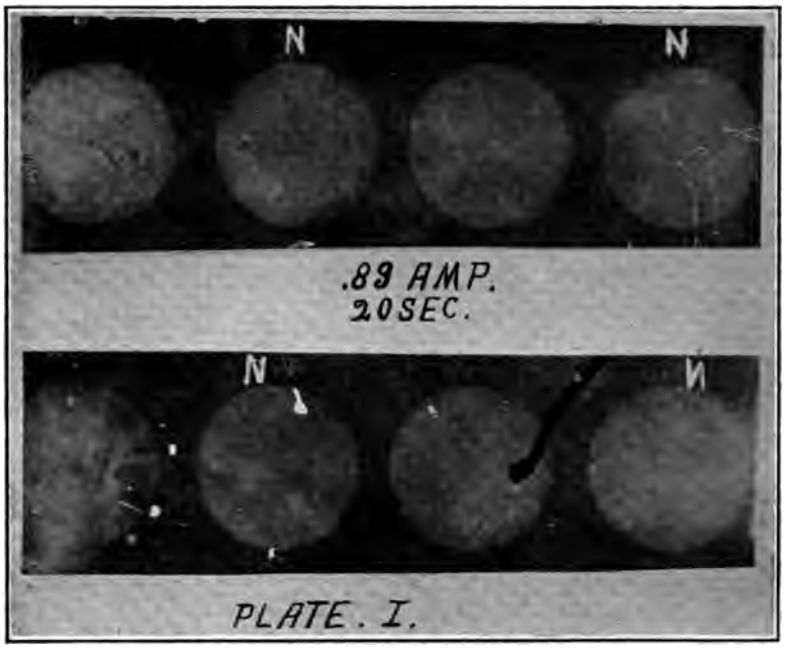


FIG. II.

B is a cardboard box in which is placed the platinum wire. The platinum wire is soldered to two copper wires which are fastened to a

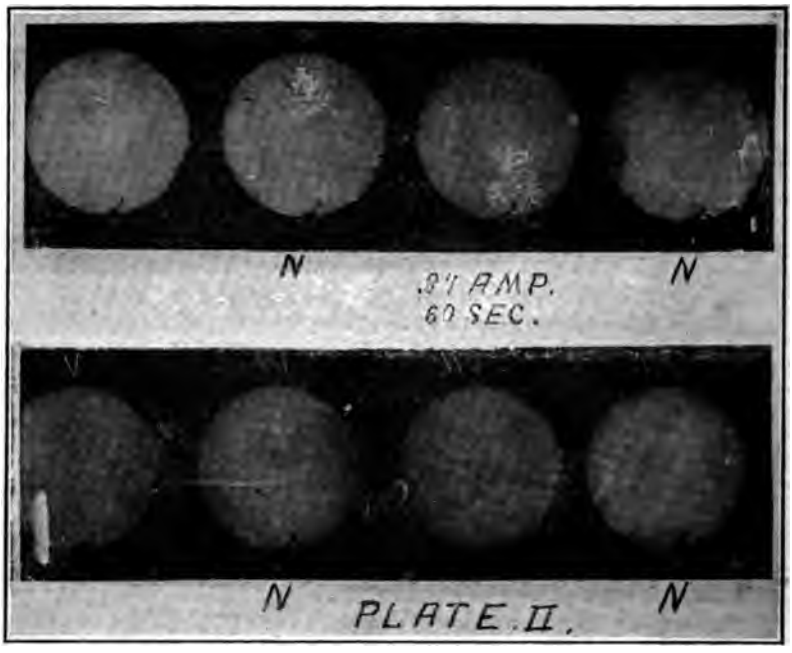
wooden block by two binding posts in order to make connection with the battery. The photographic plate was so mounted back of a block of wood about 25 cm. long, 14 cm. wide and 4 cm. thick with a hole 2½ cm. in diameter that it could be slid past the opening and a number of exposures made upon one plate.



The first two photographs taken with the apparatus just described with the time of exposure and current as indicated. There is very little if any difference between those marked N and the others. Those marked N are exposures without a lead screen inserted between the source and the platinum wire.

Calcium Sulphide.

The calcium sulphide is the luminous sulphide as prepared by E. H. Sargent & Company, Chemists, of Chicago. The sulphide was spread on a cardboard with mucilage and excited by sunlight. A tin can was placed around the iron pipe and aluminum window placed in the tin can. With this arrangement some of the external heating effects were eliminated.



Photographs III and IV were taken with the sulphide screen parallel to the aluminum window so that the rays must fall on the back side of the screen while their effect was photographed from the front side. Photograph III was taken with the sensitive plate about 4 cm. from the screen while IV was less than 1 cm. and in no case was the sulphide screen more than 25 cm. from the source. In III the exposures were alternated so that 2, 4, 6 and 8 were exposed to all radiations that might come from a Welsbach burner and pass through an aluminum window, while 1, 3, 5 and 7 were taken when a lead screen was placed

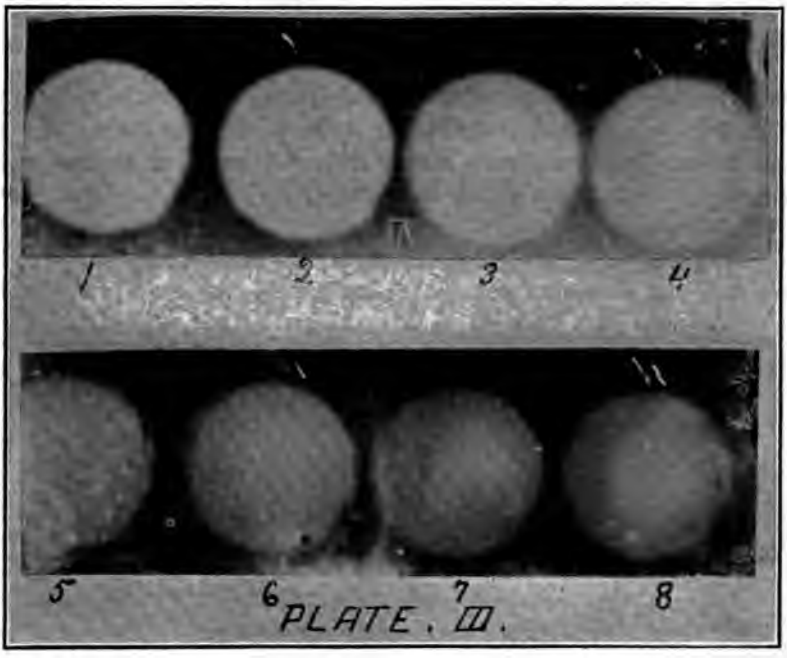


PLATE. III.

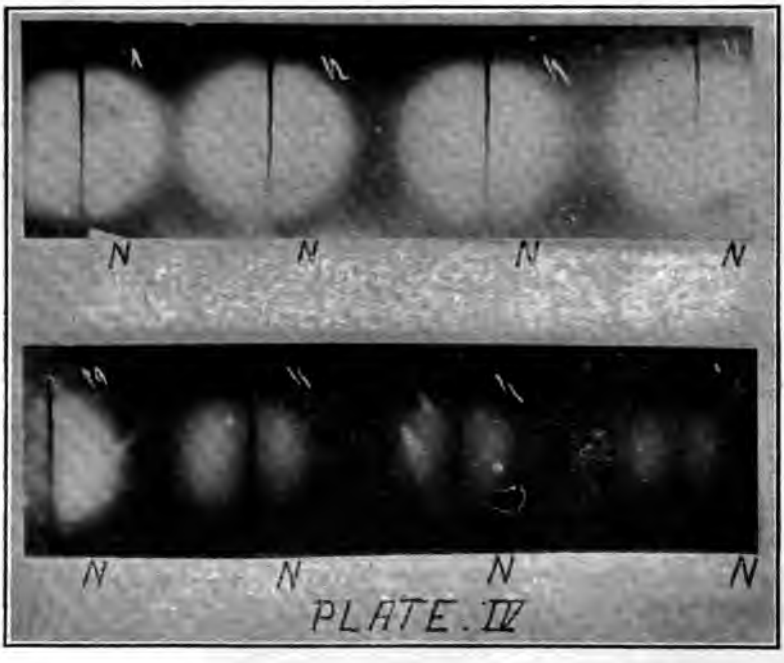


PLATE. IV

between the source and sulphide screen. In the photographs it is seen that there is a gradual decay in the luminous intensity of the screen, and if there is any radiation coming from the burner, in no case is it sufficently intense to overcome the decay or even make the rate noticeably different.

Photograph IV was taken by exposing one-half of the luminous screen to the radiations while at the same time the other half, which was screened from them by lead, was exposed. The arrangement is similar to that shown in Fig. III.

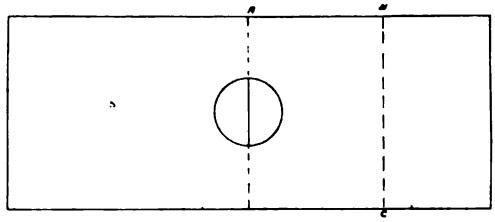


FIG. III

S is a large lead plate 1 mm. thick with a circular opening in the center, on the back of which is fastened the sulphide screen. In the line A D across the opening is a lead strip projecting 2 or 3 mm. foward. A B C D is a small lead plate on the back side of the larger one, covering one-half of the opening. With this arrangement sixteen exposures were taken on one plate and a direct comparison can be made. In the sixteenth

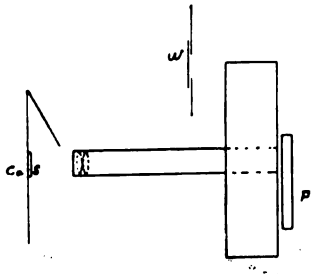
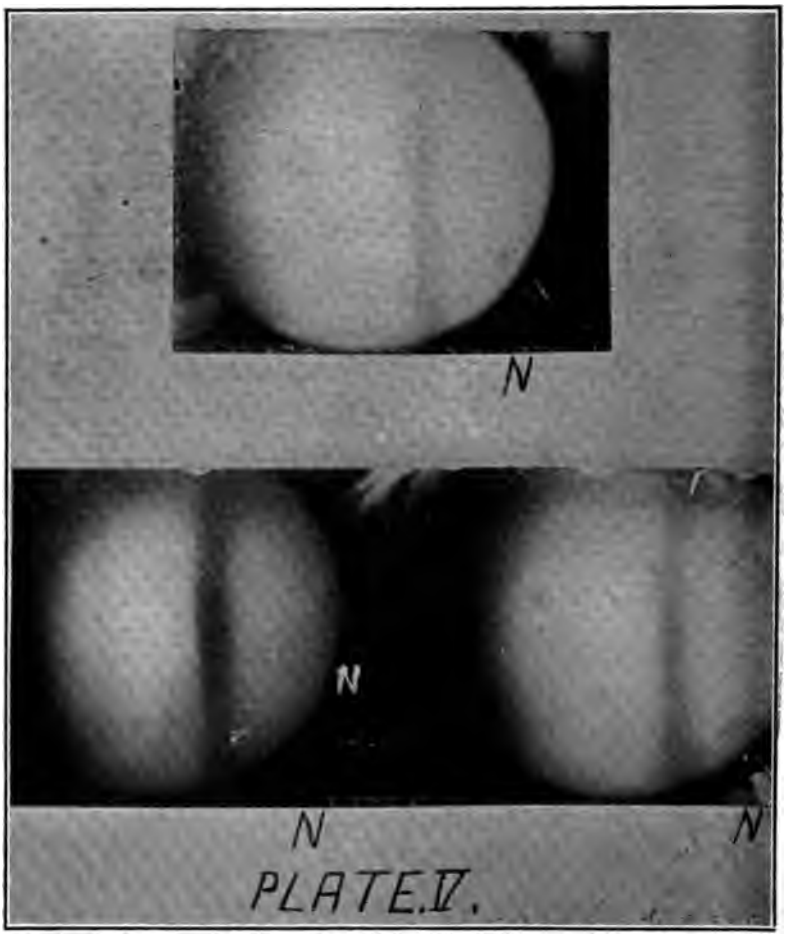


FIG. IV.

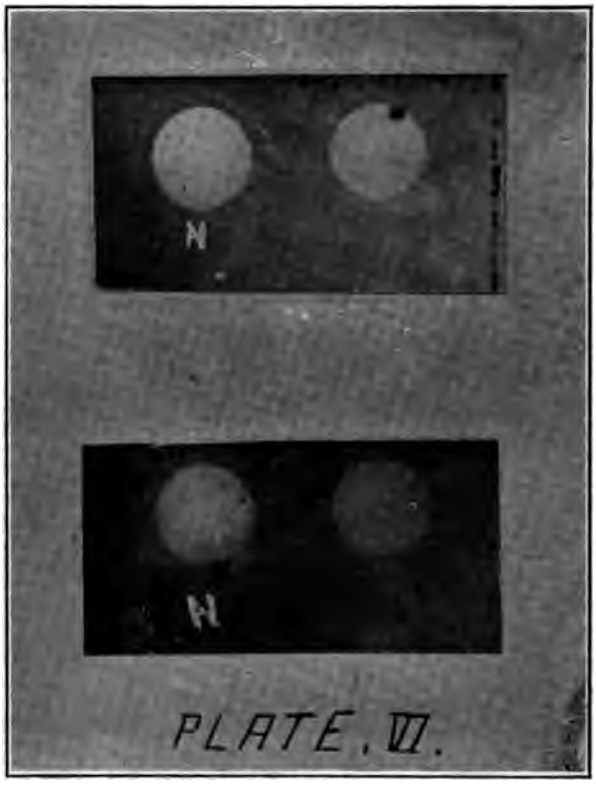
there is not much difference between the half marked N and the half not marked at all.

Photograph V is taken with the aid of convex lenses, focussing the light from the sulphide screen on the plate; by means of a lead plate,



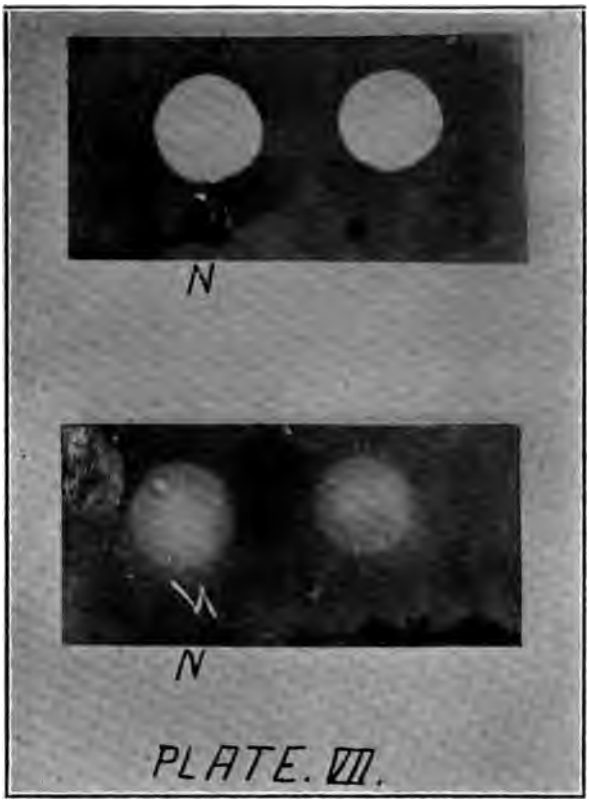
one-half of the luminous screen was screened from the source in such a manner as is shown in Fig. IV. A black strip of paper is pasted across the center of the screen to mark the halves of the luminous sulphide.

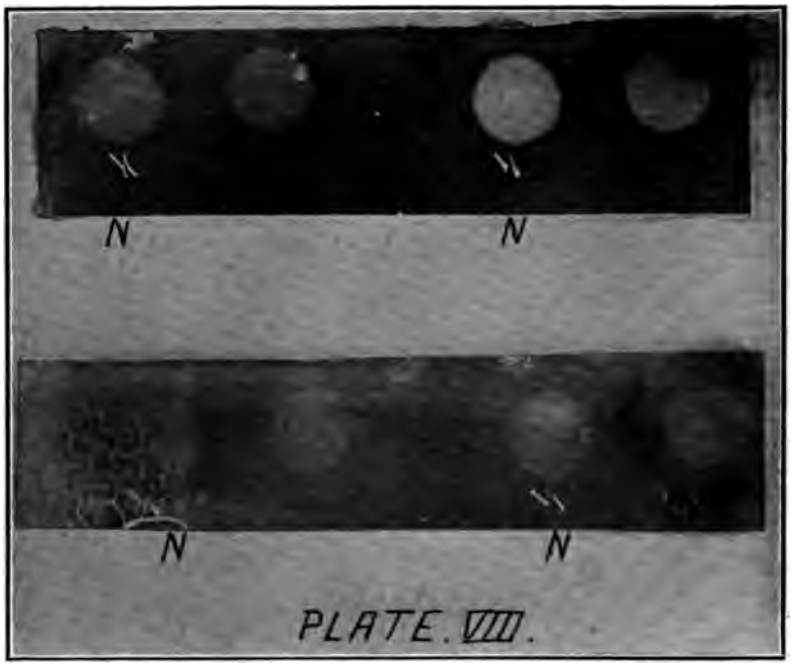
Photograph VI is a trial plate to investigate the effect of various times of exposures. The exposures marked N are seen to be slightly darker on the negative. This seems to indicate that there is a slight effect from the radiations of the Welsbach burner. Photographs VII and VIII



are to show whether or not VI is due to a radiation. VII shows similar results to VI and is taken under similar conditions. It was thought that it might be due to heat, and to prove this a lead plate was placed against the tin can, where it became heated. Exposure VIII is made with the radiation cut off by the lead plate suspended between the source and sulphide screen and shows similar results to VI and VII. The exposures

marked N are the denser on the negative, not because of a radiation falling on the corresponding side of the screen, but because of heat or of initial conditions of luminosity. The arrangement of apparatus for these three photographs is shown in Fig. V.





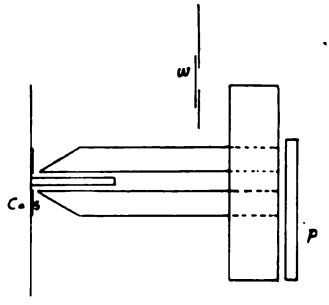
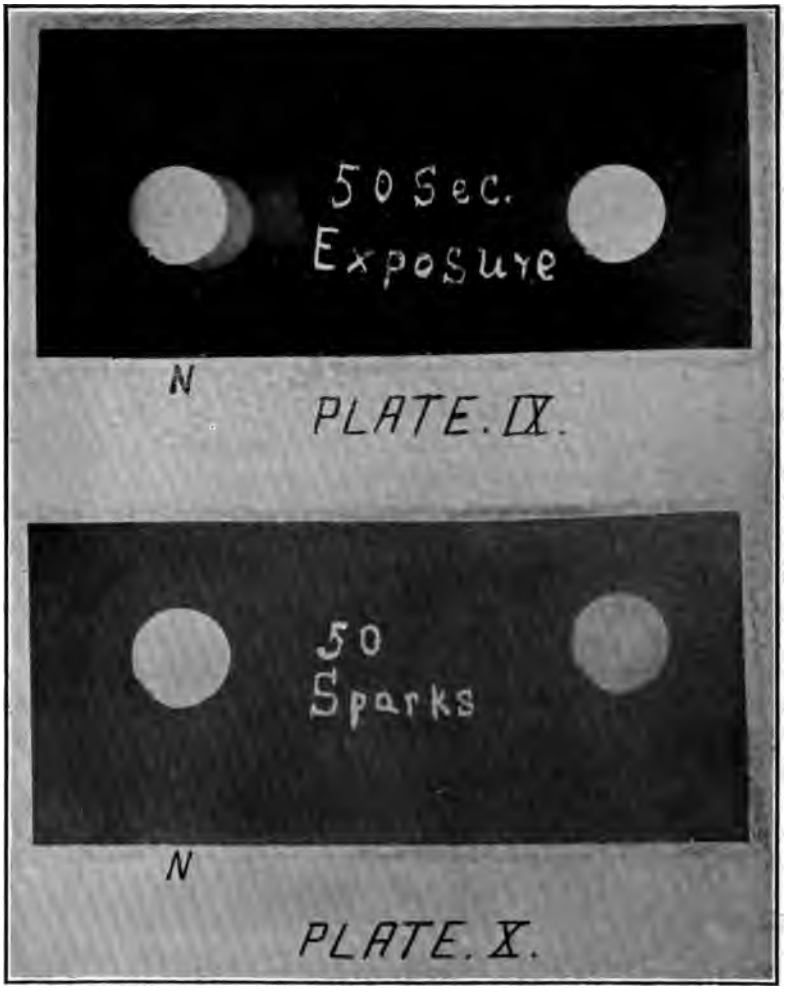


FIG. V.

FEEBLE SPARK.

The apparatus used was as described in Blondlot's work. The results were negative and only two photographs taken, both of which are given in plate IX and X. The intensity of the spark was that given by a

spark between two rounded ends of platinum wire ½ mm. diameter separated a small fraction of a mm. The potential at the spark gap was not



great enough to spark a distance of ¼ mm. While working with this apparatus a phenomenon occurred which shows how easily constant errors may influence the result. The lead screen used to intercept the radiation was suspended by cords to the top of the iron lamp chimney so as

to be easily and noiselessly swung in and out of the path of the radiation from the window. It was noticed that when the lead was interposed the intensity of the spark gap as seen through the ground glass diminished considerably and increased again when taken away. This was what we were looking for. Of course we thought that after weeks of vain effort we were to be rewarded. After changing our apparatus a little the results were just the reverse of what we expected. We also noticed the character of the sound of the vibrator of the induction coil changed in unison with the intensity. A little investigation showed that a slight pressure anywhere on the table would produce the same effect. It seemed that the vibrator was vibrating about a point of nearly unstable equilibrium. A slight change of level of the table caused the vibration to be different and thus cause a different intensity of the spark. The weight of the screen as it was swung to and fro was enough to change the level of the table, which was an ordinary wooden one set solidly on a concrete basement floor.

A three-glower 220 volt Nernst lamp was substituted for the Welsbach lamp. The results were the same as before.

Our results are all negative. After experimenting for some months and appreciating the difficulties and the various psychial phenomena that may enter we are tempted to believe, as some others do, that the various French physicists have been misled. On the other hand, when we consider that the experimenters on this phenomenon have world-wide reputation, we can not think that such men as Blondlot, Charpentier, or Becquenl would rush into print on a subject of which they were not absolutely certain, especially on one that has been called in question by noted physicists.

It is our intention to remodel our apparatus in certain respects and continue the investigation.

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The Apache Medicine Ceremonies Performed Over the Daughter of C 30.

Albert B. Reagan.

C 30's daughter, near Fort Apache, Arizona, was very sick, so the chief medicine men of the clan, having used every other remedy known to their profession, decided to use the Gunelpieya Disk performances (described in the Indiana Academy of Science for 1903) and the Medicine Ghost Dance as a remedy to make her well. This remedy is the last medical resort known to the Apache Indians. They believe that it will either cure the patient or, if he dies, will prepare him for the Happy Hunting Ground. It belongs to the faith cure side of the Apache medical practice. The Gunelpieya Disk performances are day-time ceremonies, the Medicine Ghost Dance is always performed at night. The former always immediately precedes the latter.

Having decided what to do, the medicine men set about to do it at once.

In a sheltered sunny spot they made a canvas enclosure about thirty feet in diameter. The enclosed area being then leveled, they drew a medicine disk in it some sixteen feet in diameter. This disk they decorated in concentric rings with several symbols of their gods; the sun, rainbows, deer, bird, and gods or Gunelpieya, represented by the figures of men. These they drew on the ground in various colors, the coloring material being prepared as follows: The black from groundup charcoal; the red from pulverized red sandstone; the yellowish-white from crushed limestone; and the green from groundup leaves.

The disk being completed the Gunelpieya cermonies began. The oldest grandmother present, in this case, Chinda by name, came into the canvas enclosure, walked to the center of the disk with cattail flag pollen, sprinkled each of the symbolic figures of the disk with cattail flag pollen, the sacred meal of the Apaches, called by them "Hottendin." She then took a cup partly filled with water and, beginning with the outer rainbow circle, the outer figure of the disk thus drawn, she walked around on each concentric circle, both space and bow, from the rim of the disk to its center, stooping before each sacred object to gather a pinch of dust

from it. This dust she put in the cup which she carried in her hand. Having completed her dust gathering, she prayed for a moment to the four great gods that are holding up the four corners of the earth; then set the cup down in the center of the disk and took her departure.

As soon as grandma commenced to take her leave, the sick girl entered the enclosure and, as she was too weak to walk, they carried her around each concentric circle from the outer rim of the disk to its center, placing her on the sun drawing with her face turned toward the evening sun. At this moment the musicians, who had seated themselves within the canvas enclosure in the space between the canvas and the disk, began to chant in the minor key:

"Kaws' ah tun'-nee yah' osh' kah'
Kaws' ah tun'-nee yah' osh kah'
Kaws' ah tun'-nee yah' osh kah'
Kaws' ah tun'-nee yah' osh kee' yah'.
Yah' dethith'-be'-zhe'
Pair-ris' kee-kay' ed-dee-teen'
Tsot' un-tzhon'-nee
Bair' in-dah' klee'-dal-ash'
Yah' ed-dee-teen' oo' bair' tzhon'-nee
Nod'-o-tash' yo' e' hay' nay'."

Just as the monotonous music had attracted the attention of all, a ghost dancer, called by the Indians "Cheden," came from a nearby thicket and danced into the enclosure. He was nude with the exception of dancing skirt, moccasins and hat, the latter being a square-shouldered ghost hat. This hat had for a support piece a bow-shaped withe which passed, yoke fashion, from the crown of the head to beneath the chin, where the ends of the yoke were tied together with a sinew to keep the hat in place. This withe had a muslin mask stretched over it loosely. To this yoke at the top was fastened a transverse-bar of yucca wood from which several upright pieces projected on which there were peculiarly carved cross pieces and zigzag red lines, indicating lightning. To make the ghost figure more grotesque, the dancer's body was painted in various colors. A ghost god decorated his breast and the red bolt lightning his arms. He held a butcher knife in one hand and a lightning painted wand in the other. On entering he danced around within the enclosure for a considerable time. He then walked around the circle from the east, turning con-

tinually to the right and edging in toward the center of the disk till he reached the patient, approaching her from the rear. He then laid down his knife and wand and dipped his hands in the muddy water in the cup. He then rubbed the sick one's back with the muddied hands. When he had done this he lifted his hands skyward and sent the "sick" away by

The Medicine Dancer. A Pose in the Medicine Dance.

blowing a hissing breath through them. In like manner he placed his hands on the woman's head, on her breast and on her arms. Having completed his task and sent "sick" away, he galloped off into obscurity.

When the "Cheden" had gone, chief medicine man Brigham Young went and took the muddy cup and rubbed the woman in the same manner as the "Cheden" had done before him, except that he daubed her almost all over with the mud, praying continually as he did so. When he had completed his daubing, they carried the sick woman from the enclosure.

Then each one who cared took some of the dust of the gods, that is, gathered a pinch of dust from each of the symbolic figures. This being done, the disk was obliterated. The Gunelpieya ceremonies were thus brought to a close. The next scenes were those of the ghost dance.

At about ten o'clock that night a huge bonfire was kindled in a level open area, around which practically all the Indians of the tribe gathered. Two drummers seated themselves on their blankets a little to the west of the big fire and began to beat the Indian "tomtoms," drums made by stretching a rawhide over the open face of a pot. As soon as the dull drum beats were heard all who desired to sing joined the drummers and began to chant:

To'-kwah tzhoo'-nah nahd'-o-tash'
To'-kwah tzhoo'-nah nahd'-o-tash'
To'-kwah tzhoo'-nah nahd'-o-tash'
To'-kwah tzhoo'-nah nahd'-o-toosh'-she ah' i' a' nah' ah'
To'-kwah tzhoo'-nah nahd'-o-toosh'-she ah' i' a' nah' i'.

After the singing had been going on for probably half an hour, the sick girl was carried to the place of meeting and placed on a blanket to the east of the fire. On this she reclined for almost an hour waiting for those who were to perform over her. At last they came, the ghost dancers. There were five of them, four medicine dancers and a clown. The former were "Chedens" and were all attired like the "Cheden" above described with the exception that the hats of two of them had the lath crest pieces arranged in fan shape so as to resemble the spread tail of a turkey, which it was intended to represent. The clown was attired, painted and daubed similarly to the ghost dancers, the crest of his hat, however, was neither square shouldered nor fan-shaped; but instead the lath extended out as horns from each side, a small cross cresting the hat. Besides the difference in the hat, he also had a belt of pine twigs around his waist and a bunch of fir twigs at his back that, in several respects, made him look like Christian in "Pilgrims' Progress" as he started out with his load of sins on his back. The ghost dancers carried lightning painted wands in each hand; the clown carried a thunder stick in one hand and a three-pronged stick in the other. The thunder stick was a piece of lath suspended on a string. The string being twisted, the whirling of the lath gave a sound "all the same thunder," to use the Indian expression. The three-pronged stick resembled the trident of the fabled Neptune. The

clown thus attired and equipped looked much like the pictures of Satan, whom he was intended to represent, except that he was wingless.

These medicine actors approached the congregated people from the southwest, encircled them in a great circle, made circle after circle, each time edging in toward the great fire. As they thus approached they kept

Medicine Man. C 4.

putting their heads near to the ground as if smelling for something, then gobbling and struting like a turkey and waving their hands and wands like a flying bird flops its wings.

At last they entered the sick one's presence and acting as though surprised, they danced backwards and forwards for several yards to the music of the chant:

"Kahs'-ah-tun' nee yah' ash kah'
Kahs'-ah-tun' nee yah' ash kah'
Kahs'-ah-tun' nee yah' ash kah'
Kahs'-ah-tun' nee yah' ash kee' yah'."

Then they approached again only to make a retrograde movement as before. This they did several times in succession. Then they approached and strutted around the little spot that the girl occupied, the clown going through every grimace known to his fraternity. After encircling the patient once, they pranced for a moment while "grandma" sprinkled the sacred meal upon them, blowing her breath in blessing on each one as she sprinkled him. This completed scene one of this act and the men of the gods cantered off into the darkness to go through their religious incantations to drive away the evil spirits, "sick."

The ghost dancers returned and formed in column facing the west, the sick one being changed on her blanket so that she faced them. They danced up to her feet and then retrograded in a backward movement to the spot where they had first formed the column, gobbling and strutting and waving their arms in imitation of a flying turkey. This they repeated seven times. Then the formost dancer, as he made pose after pose often imitating the actions of a mother quail when protecting her brood, left the column and danced to the feet of the dying girl. He reached her presence, strutted around her, laid the crossed wands on her, blew his breath on them, danced backwards for about twelve feet with medicine wands still crossed, parted the wands by a sweeping vigorous movement of the hands in opposite directions, thus sending the evil spirits not into the swine, but to the four winds. He returned to the patient, placed the wands on her breast, then danced backwards and scattered the evil ones as before. He then placed the crossed wands upon her head, and lastly upon her back, each time performing as above described. His work being completed, he galloped off into obscurity to appear in the next scene.

The other medicine dancers in succession went through practically the same performance as the first "Cheden" did. Then the clown came. His performing, in addition to his tumbling and rolling around in the dirt, was about the same as that of those who preceded him, except that he did not strut and gobble like a turkey. His acting completed part one of this scene.

There were three other parts to this scene all of which were similar to the one just described with the exception that the position taken by the actors was different. In part two the sick one faced the southwest, the dancing column the northeast; in part three she faced the northwest, the column the southeast; and in part four she faced the northeast, the

column the southwest. Part four completed this scene and the medicine actors passed out beyond the circle of light.

The next ten scenes were similar to the scene just described, except that when lookers-on went to sleep the Satanic majesty woke them up with his trident and made them dance, there being twenty-seven sleepy ones dancing at one time.

Just as day began to dawn the twelfth and last scene began. The

Chief Brigham Young, of the Apaches.

medicine dancers appeared, were sprinkled with the sacred dust, and began to perform over the sick one as in the previous ten scenes with the exception that they used medicine hoops instead of wands. These hoops were two and one-half feet in diameter, were five in number, were made of willow, and were painted so that the five represented the rainbow in color which they were intended to represent. Besides being painted, each hoop had five eagle feathers suspended from it.

When this scene began the young and middle-aged lookers-on took one more drink of Indian whiskey (they had been drinking it all night), formed around the central fire in a great circle, and danced around from left to right, the women in one half of the circle, the men in the other. The old women danced backward and forward on either side of the fire

Grandma Irrigating.

within the outer dancing circle; and old grandma, Brigham Young, medicine man C 4, and Loco Jim sprinkled the sacred dust and prayed incessantly to the gods. The dancing became more and more vigorous. Every one joined in it. The sound of the peculiar drum, now being beat with greater accent, the loud chanting and the deafening shouts of the dancers filled all the surrounding country with ear-grating sounds. The excitement reached a high tension. The sick one made one supreme effort to rise and join in the dance; but she had not sufficient strength. They lifted her to a standing position, they sprinkled her with the sacred

dust, they rubbed her back with scorched fir twigs, they supported her in a dancing position. She made one more heroic effort to dance and become well. Greater and greater grew the excitement. Loco Jim prayed louder, the shrieks and shouts of the dancers became deafening. The crisis came. In the excitement the sick one forgot her ailments. She danced. She took a medicine god in each hand. She lifted them high above her head. She leaped. She crow-hopped. She posed. She strutted round and round the great fire like a turkey. She called the gods by name. She shrieked, swooned and died.

Words can not describe the scene that followed. Men, yes, Indian men, wept, the women wailed with the hideous coyote yelping wail so characteristic of the Apaches. They all pulled their hair out by handfuls, they rent their apparel and destroyed their property at hand. Then all made a rush to see the corpse. They trampled over each other, and it was with difficulty that they were kept from crowding one another into the great fire. They carried her to the nearest wigwam; stripped, washed and dressed her; beaded her with all the beads of her clan; put wristlets upon wristlets on her wrists; rolled her in her best blanket; took her and her medicine accouterments to the mountain side and buried them beneath a pinyon tree. Then they returned and destroyed everything which belonged to her, both animate and inanimate, together with her father's "tepee," that the things that were hers on earth might be with her in spirit in the land of bliss. Then for thirty days the women wailed and mourned for her at morning, noon and night. Thus were the ceremonies performed over the medicine girl brought to a close.

The Apache Medicine Game.

Albert B. Reagan.

The medicine game is usually played for the benefit of the sick. A medicine man plays to drive "sick" away; an Indian, as the representative of "sick," plays against him. If the representative of the good spirits wins, it is believed that the sick one will get well; if the representative of evil gains the victory, he will die. The medicine man so plays the game that if he believes the patient will die he loses, and if he believes he will get well he wins; he must keep up his reputation as a medicine man. The game is also occasionally played to pass the time away. When played for that purpose four persons usually play, two playing as partners.

In many respects this game resembles the "Setdilth Game," described in the Indiana Academy of Science for 1903. The tally counts are 40 in number, as in that game; but pebbles instead of cobble stones are used. Furthermore, instead of being picked up on the spot, as the cobble stones are, each family carries a "set" with them wherever they go. Like the Setdilth tallies, when used in playing they are arranged in a circle; but in groups of fives instead of tens. A wide space on opposite sides of the circle, designated "water," separates the four west groups from the four east groups. As in the Setdilth game a center or bouncing rock is used. Also as in that game bouncing sticks are used, but the number is four instead of three. The sticks also are very different. The Setdilth sticks are about a foot in length, are the halves of green willows, and are thick and heavy. The Medicine sticks are two feet in length, are dry, seasoned material, are usually yucca lath, and are light and thin. Besides being variously carved, three of them have one face each painted red; the other face unpainted, or painted white. The other stick has one face painted black, the other green. As in the Setdilth game these sticks are struck endwise on the bouncing rock, and are then let fall as chance may direct. In this game, as in the Setdilth game, small sticks are placed between the last rock tally and the next pebble in the direction the player is moving his tally stick to mark the number of points he has gained. Unlike the Setdilth game, 41 points instead of 40 constitute a game-count; the players begin at the south wide space and in order to get

a game they must cross this same space on the return to at least one count on the other side.* Below are the rules of the game.

Rules for Playing.

1. The opponents in the game face each other, both start from the south wide space, and move their counting sticks around the stone circle in opposite directions, each playing as his turn comes.

2. Should the counts of two opponents be such that their counting sticks would occupy the same space, the one who played last takes up his opponent's counting stick and throws it back to the starting point. Its owner must begin the game anew, as all the points he has previously made are lost.

3. Should the counts of any player be such as to place his counting stick in either of the wide spaces, designated "water," he looses all the points he has made, his counting stick is thrown back to the starting place, and he must begin again.

Rules for counting the points, decided by the face of the sticks that are up after they have fallen (the faces according to color will be designated white, black, green, or red).

1. Two white plus one red plus one black, two points.
2. Three red plus one black and all the sticks straight and parallel, 5 points.
3. Three white plus one green, 10 points.
4. Three red plus one green, 13 points.
5. Three white plus one black, 13 points.
6. Three red plus one black, 20 points.
7. Three red, one crossing the other two, plus one black, 26 points.
8. Three white plus one black laying across the others, 39 points.
9. Three red, one crossing the other two, plus one black crossing two red ones (in this game each cross counts 13 points), 52 points.
10. One hundred and sixty-four continuous points or four game-counts constitute a game.

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*The winner of the game-count keeps on playing, retaining the extra points he has gained; his opponents begin anew. They, however, do not lose any game-counts previously gained in the game.

All Saints Day at Jemez, New Mexico.

Albert B. Reagan.

As the Jemez Indians are Catholics, they observe All Saints Day as other Catholics do, but after their own fashion. Whether mass is held in the Jemez church on that day or not, at daybreak the sexton commences to pound the two bells in the belfry of the church alternately with a hammer. This pounding he continues till sun up. The Indians then commence coming one by one to give gifts as prayers for the good of all saints. Some of these gift-carriers have baskets of grain, some baskets of fruit, others baskets of baked bread. On entering the church, each gift-carrier proceeds to the altar, and, having made the cross and said the appropriate Catholic prayer, he places his gift upon the altar and leaves the church at once. On going out of the church he pulls the two bell ropes as often as he chooses, causing the clapperless bells to pound each other into a dull monotonous choppy ringing, thus declaring to the village and to his God that he has deposited his gift. This gift depositing is carried on throughout the entire day. The proceeds, thus obtained, are given to the priest.

The Moccasin Game.

Albert B. Reagan.

The Moccasin game is an Apache nocturnal game. It is played by the men only. The players and spectators gather in a circle around a fire, which serves both for warmth and light. The players divide themselves into two groups, one of these groups occupies the west, the other the east part of the circle, which now assumes the form of an ellipse. Then the sides begin to bet. One side puts up a saddle that it will win the game. The other puts up a horse. So the betting goes on till the members of each side have staked on the game practically all they have. Then the game begins. It is on the same principle as the "chuck luck" game of the English walnut hulls and the pea, except that it is more complicated. It is a straight game of guess.

There are two ways of playing this game. In the one (that used by El Sa Say's band) each side has seven round holes dug in the earth to the depth of about six inches. These holes are filled with leaves or fine bark; and the ground in the immediate vicinity is covered with the same material till the holes are practically hid from view, and instead of a pea a round pebble about the size of an egg is used. In the other style of playing, mounds of earth and variously arranged ridges are used instead of holes; the pebble being used as in the first case. Should mounds of earth be used, linnear marks are made on them to show the possible places that the ball (pebble) may be hid.

In playing the game, if it is the first one of the season, the sides draw by lot to see which will get the pebble, that is, which will get to play first. At all other times the winner in the previous game gets to play first.

The lots having been cast, a member of the lucky side, while he and his game ground are obscured from view with a blanket, puts the mystic* pebble in the bottom of one of the holes; or, in case mounds or ridges of earth are being used, buries it in the dirt beneath one of the linear lines. Then he carefully covers and smoothes everything all over so that the location of the pebble can not be detected at all. This being done, a

* So called "mystic" because each set of players pray over their respective stick and pebble that they will have power to favor them in the game.

member of the opposing clan with divining stick (a small club-like stick) in hand goes over to the other's game ground, so to speak; and, after making six false motions with his stick while he argues and jokes with his opponents to see if he can decide from their actions where the valuable pebble is, he strikes the hole or spot, in case a mound or ridge of earth is used, with vigorous force in which he has decided the stone is. Then there is a lull, a death silence, while he removes the leaves or earth, etc., to see if he has won. If the pebble is not in that place of deposit the players who occupy that ground have won the tally and immediately begin the song of triumph.

Yah e yi,
Yah e yi,
Ain-nee ah,
Ain-nee ah,
Hay hay ah hay ah ah ah a.

The player with the mystic stick goes back to his clan, and the holders of the pebble hide it again. Then another one from the opposing side tries his luck in finding it; but usually with no better success. In this way the game continues for hours. At last a member of the losing side locates the mystic stone, and, amid the shouts and song of triumph of his clan, he takes it to his side of the great ellipse. The other side then begins to guess. This sort of performance is kept up till one side receives the number of tallies previously decided upon to constitute a game. That side consequently wins the game and sweeps in the stakes.

Rules for Playing the Game.

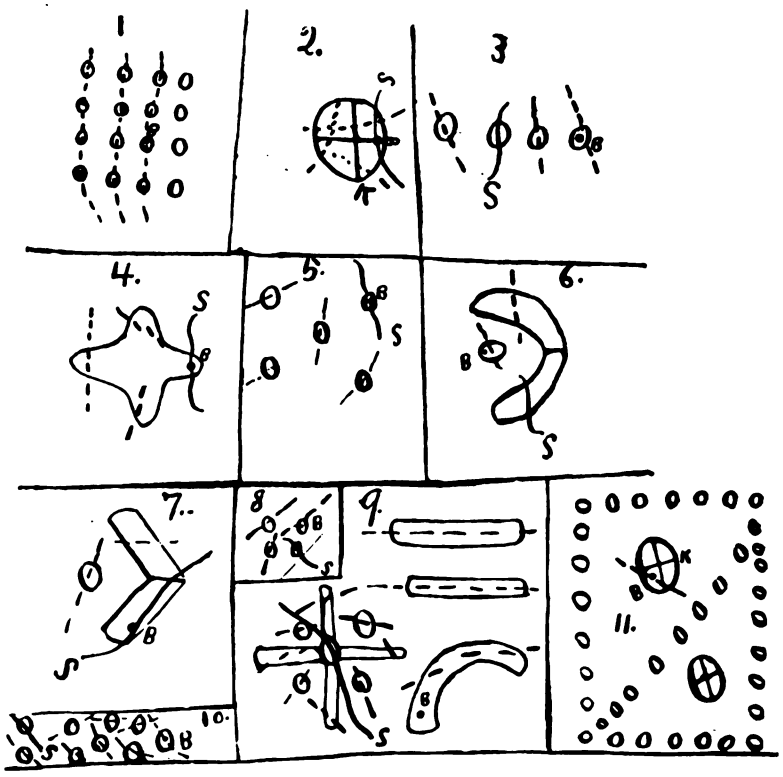
1. If in the preliminary or false motion movement the pebble is uncovered, it counts one tally for the side which has the pebble, that is, for the side which has buried it.

2. If the pebble is located at the final stroke, not the preliminary strokes, of the mystic stick, it counts one tally for the side which has the stick, and that side takes the pebble to its own game field. The other side then begins to guess.

3. If the pebble is not located in the final stroke, nor the preliminary strokes of the mystic stick, it counts one tally for the side which has hid it. And that side retains it and hides it again.

4. There is always one less false motion of the mystic stick than there are possible places for the pebble to be hid; for example, in case there are seven holes in any one of which the stone may be hid, six preliminary strokes of the mystic stick are always made.

5. There are always two tally keepers, one representing each opposing party. At the beginning of the game each of these has a number of



Map showing the various arrangements of the moccasin game field of the dirt type, used in playing one game at the camp of Chief R 6 the night of February 24, 1902.

The broken lines indicate the false or preliminary motions.

K shows lines where the pebble should be hid.

S shows the final stroke. It is represented by a continuous line.

In 1 and 11 the pebble was uncovered in the preliminary motion. In 3, 6, 8 and 10 it was passed over in the preliminary strokes, but not uncovered. In 2, 4, 5 and 7 the pebble was uncovered in the final stroke. And in 9 it was missed both in the preliminary and final strokes. 2, 4, 5 and 7 are the only ones which counted points for the searchers for the pebble. In each of these four cases they got the pebble and took it to their own game field.

bear grass blades, "Indian shoe strings," corresponding to the number of tallies decided upon to constitute the game. When a side loses, the tally keeper of that side gives a blade of grass to his opponent tally keeper. When all the "Indian shoe strings" have passed to the possession of any one side, that side has won the game. It is sun up by that time and all go home, one half paupers, the other half as rich as the Indian generally gets.

Words used in the moccasin game:

Ako. There (used when making a false motion as if to grab the ball).

Don-dee. It is well.

Kod-da. It is ready, the ball is hid.

Tah-al. It is finished.

Oa-kog-go. That is all.

Ah-ko. Here, it is here.

Doh. Play.

Yah-lan-nee. Good-bye, you have lost, you are left, etc.

Ken-not-tah-hah. The moccasin game (so called because originally the pebble was hid in a moccasin).*

*Taken from the Apaches, their manners, customs, etc., furnished to the Bureau of American Ethnology by the writer.

The "Matachina" Dance.

Albert B. Reagan.

The "matachina" is a peculiar religious ceremonial dance of the Pueblo Indians of New Mexico. It is a religious rite performed in celebration of the birth of Christ. This dance was acted out at the annual feast of the patron saint, Guadalupe, at Canyon de los Jemez, New Mexico, November 12, 1901.

After mass was given at the holy church of Saint Guadalupe, the dancers, some thirty in number, lined up in two rows with the chief of ceremonies at the front and between the rows. All were masked. The chief of ceremonies wore a mask that resembled the head of a donkey very much; and each of the dancers wore a cloth mask. Each of them also wore a circular cap from which there floated to the breeze variously colored ribbons.

When all the performers were in their proper places, the chief of ceremonies began to writhe and to wriggle his body in a laborious manner. This performance was to indicate that with the birth of Christ a furious battle was waged againt sin. As soon as the chief began to perform, the gaudily-attired dancers commenced to move their limbs in a lively manner to the strains of an accordian. They pranced about much in the same way that a baboon trips about in a cage. This spectacular and, at times, grotesque acting was kept up till the sun set. Then the simple-hearted Indians set out for their homes feeling that they had done their duty, that they had been forgiven for their transgressions and that they would begin a new year with unsullied records.

The "Penitenties."

Albert B. Reagan.

At the conquest of New Mexico by the Spaniards, the Pueblo Indians were converted to Christianity. From the first they were very attentive to the teachings of the Catholic priest, but they could not grasp the new creed in its entirety. They were handicapped by the fact that they were not able to read or write. The Bible could not be used as an instrument for their instruction. They had to depend upon the words of the priest only. As a result Christianity, as practiced by the Pueblo Indians today, is greatly "distorted."

The "padres" taught penitence. The Pueblos began in easy stages, but soon corrupted the religion; and now many of the Indians undergo excruciating torture annually to atone for the sins of their respective village. In June of each year there are invariably a number of young Indian men who volunteer their flesh for the elevation of their people. In each village several are selected who lead a procession, composed of nearly every inhabitant of the village. One of these "penitenties," as the Mexicans call them, as late as even the eighties, carried a massive cross in representation of Christ's carrying the cross to the crucifixtion. This one seldom returned alive. In this performance of the "penitenties," the Indians who are not acting as "penitenties" arm themselves with cactus; and each in turn, pricks the "penitenties." The more cruel the nature of the torture, the more nearly have the people of the village been forgiven by the Supreme Being for their sins during the year. The flesh bruising part of the ceremony being finished, the suffering subjects, bleeding from head to foot, are carried back to the church, where prolonged and weird ceremonies are conducted. This human offering is followed by the "Matachina Dance," described in a previous paper—a curious ceremony performed in celebration of the birth of Christ.

The Cliff Dwellers of Arizona.

Albert B. Reagan.

The cliff dwellers of Arizona were small of stature, the adult male not being over fifty-two inches in height. Their skulls are brachycephalic (or broader across than lengthwise), like those of the Zunyis, Aztecs and Peruvians. Their skulls have also a little extra bone in the back part of the head, a peculiarity of the Incas, and known as the Inca bone. This bone seems to indicate a close relationship between this mysterious race in Arizona and the semi-civilized races of South America.

The cliff dwellers lived in narrow canyons that afforded water for cooking and drinking purposes, and for irrigating their fields. At the sides of the canyons, under the projecting cliff, they built their adobe houses, so that the cliff protected them both from rain and storm, and from the attacks of an enemy, except at the front.

Besides the cliff home that the cliff dwellers lived in in time of peace, they had caves, natural caves in the rocks, into which they retreated when hard pressed by an enemy. The large cliff cave on the East Fork of White River just east of Fort Apache is an example. At this place a continuous cave, composed of chiseled-out narrow passages, corridors and rooms, runs back along a fissure some 200 feet beneath the surface, it is said, for a distance of four and a half miles.

In case the cliff dwellers could find no cave, they changed their place of habitation, in time of great danger, to the lofty heights above the canyon floor; and there built a village on some projecting ledge. Such a village stands out against the almost perpendicular walls of the Sierra Anches mountains more than a mile in altitude above the floor of Cherry Creek canyon below.

Their dwellings, except of course the caves, were adobe structures. They were built under and against a cliff; and resembled the old Pueblo style of house very much. The second story was set back a little on the floor of the first; and the third story set back a little on the floor of the second; and so on till the "step-front like" house was finished. In each house there was but one door, a hole in the roof of the highest room. From the ground to the top of the first story, and from story to story lad-

ders extended, over which one had to climb to gain entrance to the house. In time of trouble and always at night these ladders were most likely carried to the roof and placed within. The house itself was a fortress.

These dwellers of the cliffs were an agricultural race. They farmed in the little "flats" adjacent to their places of abode, as the remains of their irrigating ditches show, as well as their grain bins. Some of these grain bins were visited by the writer; and were found partly filled with corn cobs and barley heads, from which the barley kernels had been removed by vermin. The barley heads, thus found, seem to indicate that this people knew nothing of the art of threshing grain even with a flail; but in harvesting it they headed it, and stored it away in the head. Then, when they desired to use any of the grain, they threshed it by a hand-rubbing process.

In religion it can at best be stated that the cliff dwellers were sun worshipers, as is shown by the drawings on the vases and urns which they used in their exercises of worship. One of these vases, found by the writer in a Canyon Creek cliff house in Arizona, was jug shaped, except that it did not possess a neck. Around the circular opening at the top were drawn the rays of the sun in red and black. Many more of their vases have similar drawings on them. Further evidence concerning what their religion consisted of, is thus far wanting.

Who these cliff dwellers were, where they came from and what became of them, is a matter of conjecture; and will probably remain so.

The Rosebud Indian Celebration.

Albert B. Reagan.

The Rosebud Indians, like all other Indians, love to feast and make a great display. Feast days are their great days. At the present time but one feast is allowed them each year, that of the 4th of July. This year (1904) the Rosebud Sioux celebrated at two different places, at Cut Meat and at Butte Creek. The author attended the celebration at the latter place. Below are his observations:

Medicine Lodge and War Bonnets.

The morning of the 3d of July the Butte Creek Indians went into camp on the previously prepared celebration ground. This was a circular flat a mile in diameter with an artificial grove and circular arbor in its center. No building of any kind was on it. Nothing only a trader's

stand. Towards evening of that day other Indians began to arrive. A wagon train, carrying the United States flag as a banner, was reported approaching from the south by the Butte Creek Agency wagon road. At once the braves in war paint and feathers made a mimic raid on horse back upon the train, treating it as an immigrant train. The would-be immigrants, on seeing the painted savages charging furiously towards

Eating Puppy Soup.

them from a slight rise of ground, hurriedly unhitched their horses, put them and their families in the rear and made a breastwork of their wagons. Then they waited the onslaught. This came almost immediately. Guns were fired in all directions, and the blood curdling war-whoop filled the air. In fact it looked so much like a real battle that many of the Indian women were scared. For some minutes the sham battle raged, then the wagon train surrendered. The wagons were again hitched to, and the train was taken into camp by the captors.

Nothing further of interest happened till dawn the next morning. Then there was an elaborate parade, followed by religious services con-

ducted by the Reverend Dallis Shaw (Indian). As these services were closing, a giving away scene commenced. Each Indian who desired walked to the center of a congregated circular area, told the people how good he was and exploited the good deeds of his ancestors. Then he walked around the circle handing dollar upon dollar to his friends or "dishing" out groceries to them. This he varied in a few cases by leading

The Parade.

a horse into the circle and turning it loose to be taken by anyone who wished it. Breakfast followed this scene. It consisted, for the most part, of puppy soup and dog stew. It was eaten at the medicine lodge. After breakfast came the Indian brass band parade, then the Omaha Dance in the grove. In this dance several Indians chanted in the minor key, a squaw or two sang soprano, and an Indian beat the drum. The dancers were all men, were painted, daubed and decked with feathers. Each one wore a war-bonnet. And when dancing each crowhopped around somewhat like a baboon trips about in a cage.

While these were acting, the giving away performance, which always accompanies this dance, was going on. The principal things which were being given away were horses. A buxom young squaw would ride a horse into the center of the arbor, and whoever desired the horse would take its halter-rope and lead it away. This performance continued till the United States officials put a stop to it. The remainder of the day was spent in feasting.

The remaining celebration exercises, consisting principally of horse racing and feasting, lasted three more days. Then Uncle Sam's men declared the ceremonies at an end, and the Indians returned to their respective homes.

Notes Upon Some Little Known Members of the Indiana Flora.

(PAPER NUMBER TWO.)

Chas. Piper Smith.

A year ago I gave some notes from my studies in systematic botany, for the summer of 1903, in a paper under the above heading. Certain facts gleaned from my studies the past season, seem to justify me in offering a continuation of that paper. A review of Dr. Coulter's catalogue of the State flora and of all of the subsequent "Additions to the flora ——," etc., in the Academy's "Proceedings," indicates that a few of my recent takes are not reported from the State. Two or three are, however, undoubtedly migrants, though evidently here to stay.

Specimens verifying most of these records have been placed in the herbarium of Mr. Harley H. Bartlett. These are now with him at Harvard University and have been critically examined and compared at the Gray Herbarium. Almost all are also represented in my collection of plant seeds. In accordance with Mr. Bartlett's request, I include a few records which are strictly his own. In reality his name should appear with mine as joint author of this paper.

Avena fatua L. (Marion County.)

A half dozen specimens of this well-marked oat were found by Mr. Bartlett and myself along the "Monon," at the State Fair Grounds, Indianapolis, in July, 1903. About the same number of plants was noted there by myself in August, 1904. An introduction from Europe, it is abundant in California and is not reported east of Minnesota by Britton and Brown.*

Uniola latifolia Michx. (Madison County.)

A small patch found along White River near Anderson. Jefferson County is the only station report by Dr. Coulter.†

Bromus tectorum L. (Tippecanoe and Madison Counties.)

This grass has been recently admitted to the State flora.‡ It is abundant where found at Lafayette and Anderson.

Bromus brizæformis Fisch. and Mey. (Laporte County.)

Found commonly along the Michigan Central R. R. from near Michigan City, Indiana, to New Buffalo, Berrien County, Mich. Said

by Britton and Brown to be "sparingly introduced into Pennsylvania; also from Montana to California. Native of Northern Europe and Asia."

Carex folliculata L. (Laporte County.)

Common in a small tamarack swamp northeast of Michigan City. Carex intumescens Rudge was also taken in a wet wood south of Michigan City.

Carex monile Tuckerman. (Madison County.)

Taken in a small bog along the Big Four Route, southwest of Anderson. Reported only from Gibson County in State catalogue.

Carex trichocarpa Muhl. (Madison County.)

An abundant rank-growing sedge in boggy places along White River, above and below Anderson.

Carex hystricina Muhl. (Madison County.)

Reported only from extreme northern counties. Taken in a low wet place south of Anderson. Noted as scarce.

Carex aquatilis Wahl. (Laporte and Marion Counties.)

Taken by Mr. Bartlett near Indianapolis; by myself south of Michigan City.

Carex costellata Britton. (Laporte and Marion Counties.)

Also taken near Indianapolis by Mr. Bartlett and near Michigan City by the writer.

Carex lanuginosa Michx. (Madison and Delaware Counties.)

Taken by me near both Anderson and Muncie. In the State catalogue Jefferson County is the only definite station given, but the species has been later reported from Kosciusko County by H. W. Clark,§ and is probably well distributed over the State.

Carex gracillima Schwein. (Madison County.)

Taken near Alexandria. Not common.

Carex Davisii Schwein. and Torr. (Marion County.)

Taken by Mr. Bartlett at Indianapolis. Scarce. Steuben County seems to be the only other station on record.

Carex grisea Wahl. (Marion County.)

Taken by H. H. Bartlett near Indianapolis in 1903.

Carex mirabilis perlonga Fernald. (Madison and Delaware Counties.)

Taken near Anderson and Muncie by the writer.

Carex alata ferruginea Fernald. (Marion County.)

Taken near Indianapolis by Mr. Bartlett.

Juncoides campestre bulbosa **Wood. (Marion County.)**

Taken by Mr. Bartlett near Indianapolis.

Lilium umbellatum **Pursh. (Starke County.)**

Taken by me in "swampy meadows." This plant is reported in two different places in the Academy's Proceedings for 1901 (pp. 164 and 301). I note it here because of the environment in which I found it.

Atriplex patula **L. (Marion County.)**

Very common in waste places in Indianapolis, especially along Central Avenue. Recognized in 1903 and omitted from my last paper through mistake. Reported from Steuben County by Bradner; but omitted from the State catalogue (see p. 607 of same) because of lack of verifying material.

Atriplex hastata **L. (Madison County.)**

Taken at Anderson. First reported from Wells County by C. C. Deam.

Tragopogon pratensis **L. (Madison County.)**

Common along the C., C., C. & St. L., near the Quartz Works, Anderson. Taken both in bloom and in fruit.

Antennaria fallax **Greene. (Marion County.)**

Taken by Mr. Bartlett at Indianapolis, river-bluffs opposite Fairview Park.

Mr. Bartlett's work at the Gray Herbarium has led us to change our view concerning one of my records of 1903. An annotation in the herbarium copy of Britton & Brown's "Illustrated Flora," to the effect that the characters and figuring of *Carex Baileyi* Britton do not hold good as regards the material in the herbarium, led Mr. Bartlett to compare the specimens, determined by us as Baileyi, with the herbarium material. As our specimens agree with the typical *Carex lurida* Wahl. (of which Baileyi is there regarded as a sub-species), in spite of Britton's key, etc., I feel it advisable to cancel my records of Carex Baileyi.

---

* Illustrated Flora of the Northern States and Canada: I, 173.

† Flowering Plants and Ferns of Indiana, State Geol. Report: 1899, 643.

‡ Additions to the Flora of Indiana: Proc. Ind. Acad. Sci.: 1900, 137.

§ Flora of Eagle Lake and Vicinity: Proc. Ind. Acad. Sci.: 1901, 162.

Physiological Apparatus.

Frank Marion Andrews.

Introduction.

It is frequently the case that much of the apparatus required to carry on work properly in Plant Physiology is so expensive that for any one laboratory to possess all that is needed is quite out of the question. This has led me to plan and have constructed a few very desirable pieces, concerning which this paper makes mention. I am aware of the fact that no lack of contrivances have been made to illustrate some of the principles here set forth. However, for simplicity of construction and perfect adaptation to the purposes for which they were intended, they will certainly be found superior in many ways and useful by any one interested or engaged in physiological work where such apparatus would be involved. It has therefore occurred to me to describe the various pieces of apparatus as concisely as possible and present them, together with the illustrations, in the following brief account:

I. Heating Stage for the Microscope.

This piece of apparatus consists of a rectangular sheet of copper, 60 cm. long, 8 cm. wide and 2 mm. thick. Figure 1 shows a view of the lower side. It will be seen from this view that the copper does not rest directly on the stage of the microscope but is held away from it a distance of 1 cm. This is accomplished by a strong frame of wood B,

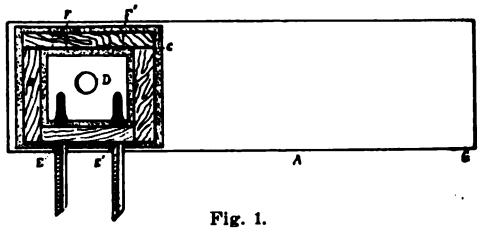


Fig. 1.

7 cm. square and 8 mm. in height. Between the wood and the copper, as an extra preventive against the conduction of heat in long continued experiments, a layer of asbestos 2 mm. thick is interposed at C. The

frame of wood and asbestos is fastened firmly to the copper A by copper screws, which, however, must not reach through the wood B. In the center of the wood and asbestos squares is a circular opening D, 12 mm. in diameter, to allow the light reflected through the stage of the microscope to pass through the slide. Through the side of the wood frame away from the pillar of the microscope, as the heating stage lies in the proper position on the stage of the microscope for observation, are two holes for centigrade thermometers, E and E'. The temperature at E may be a little less than at E', and if this is the case, then an average of the temperatures shown by the thermometers at E and E' should be reckoned. It should be ascertained before the experiment that the two thermometers read the same at the same temperature. As they project directly in front during correct observation, the temperature of both is easily seen while experimenting. Since it is not always possible or convenient to carry on experiments with the copper plate of the heating stage directed to the right as would necessarily be the case with the thermometers on the side shown in Figure 1, another arrangement was resorted to. On the side of the wood frame opposite E and E' are two similar holes for thermometers, F and F', which allows observation while the copper plate of the heating stage is turned to the left or the reverse position to the one in which E and E' could be used. It will be seen from the lower view of the heating stage shown in Figure 1 that the bulbs of the thermometers rest against the copper plate inside the asbestos square C, and in this way the heat is readily conveyed to them. One thermometer only might be used, but the use of two is more accurate and therefore advisable. A third position for the heating stage is possible and for various reasons sometimes advisable, in which the copper plate A is directed away from the observer instead of from the left or right. Or it may be turned about on the stage of the microscope through an angle of somewhat more than 180° and still be capable of perfect use at every point. It is held to the stage of the microscope by means of iron clamps, the upper screw of which is provided on its lower end with a small wooden block covered with asbestos. This is necessary since a careless disregard or misuse of subtances that are not poor conductors of heat may readily result in injury to the microscope. Heat may be supplied by a gas or alcohol lamp or other source placed under A at G and the flame increased or moved toward C as is desired.

II. Temperature Box.

This temperature box is made of galvanized iron. It is 25 cm. long, 9 cm. wide and 3 cm. deep, all inside measures. It is held to the stage of the microscope by means of a curved iron clamp hooked over the edge of the box at A. Near the lower side B is a rectangular slit 4 cm. wide and 4 mm. high, extending entirely across the box for the reception of a slide carrying the object for observation. By noticing Fig. 2 it will be

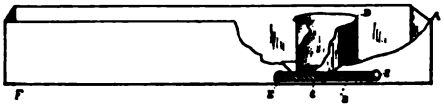


Fig. 2.

seen that the slit, B, is elevated about 2 mm. above the bottom of the box as at C, thus allowing the hot or cold water used to flow under and all around the space occupied by the slide. By this means the temperature may be increased or decreased as desired, in B to the most perfect state of efficiency possible in such a simple contrivance. At D is a cylindrical tube 3 cm. high and 2.5 cm. in diameter for the reception of the objective. In Fig. 2 both the tube D and the side of the box toward the observer are cut partly away to show the interior. The top is provided with a lid. By means of a proper mixture of salt and ice it is possible to reduce the temperature in the slit B, as shown by the thermometers kept constantly in the spaces E and E^2, to zero centigrade or below. If, however, a high temperature is desired, this may be accomplished by placing a flame under the end of the box F which projects over the stage of the microscope. Or one may arrange a vessel, somewhat higher than the box on the stage of the microscope, and by placing a lamp under this vessel, which is nearly filled with water, easily heat it to any desired temperature as shown by a thermometer. This heated water could then be siphoned into the box A and out again, and in this way the desired temperature in B obtained. The inflow and outflow to A can easily be regulated and made uniform by opening or closing pinch-cocks fastened on the rubber tube. Injury to the microscope is prevented by a sheet of asbestos placed on the stage. This temperature box can be turned either to the right or left or turned and used in any angle of 180° or less.

III. Centrifuge.

This consists of a wooden frame 60 cm. long, 55 cm. wide, and varying in height from 30 cm. at the lowest point at A to 60 cm. at B. Fig. 3 gives a view of the apparatus as seen in vertical median longitudinal

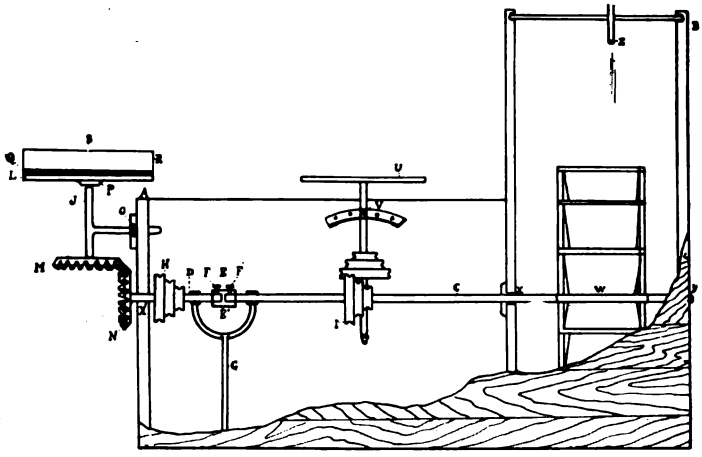


Fig. 3.

section. This apparatus in part resembles the centrifuge figured by Detmer, but is larger and possesses many improvements over his apparatus (Detmer Pflanzenphysiologie Zweite Auflage, 1895, p. 384). The machinery consists of a brass shaft 70 cm. long, in two sections C and D, which at E may be connected or disconnected by tightening or loosening the clamp E^1 by screws F F^1. In this way part or all of the machinery may be run at one time, which is often desirable. The ends of the shaft are held by a support G near E, and on D is a cone-pulley H by means of which it may be driven by other power if so desired, or from which power may be taken for other purposes if the cone-pulley I on C is in use. On the end of the shaft D is a bevel-gear arrangement so that motion is transmitted at right angles to D in the shaft in J which carries the disk L. By exchanging the position of M and N a faster motion of L may be obtained, with no increase in the speed of D. Again by using a still larger cog at N and a smaller cog at M, any speed desired may be had. By a vice versa arrangement of cogs a very slow rotation of L is effected. It is of course to be understood that by varying the size of the cogs M

and N, the distance of J from N must also vary in two obvious directions. This is done by the screw O (Figs. 3 and 4), which holds the support of the shaft carrying L. The shaft carrying the disk is enclosed for the sake of firmness in a sheath J. It is fastened to a disk of iron P. (Figs. 3 and 4), and this is held to the wooden disk of pine L, which is 20 cm. in diameter and 2 cm. thick, by means of screws. Larger disks of wood can, by means of these screws, be substituted for L and therefore the centrifugal force considerably increased aside from the ways of increasing the speed by the cone-pulley and bevel-gear arrangement above referred to. The centrifugal force brought to bear on the objects under investigation may also be increased by being placed near the periphery of the disk L, or decreased by moving them nearer the center of L. The disk of wood must in all cases be first boiled thoroughly in paraffine to prevent swelling. The disk of wood L is covered by a circular sheet of cork Q. This serves for the attachment of seedlings and plant parts to be centrifuged, and to it also are fastened several layers of wet filter paper for keeping the seeds moist. A glass crystallizing disk R, which will exactly fit L, is placed over it and darkened by being painted thickly on the inside with black paint. R is held to L by clamps. In order to water the seedlings when the machine is run for a long time, a hole is bored exactly in the center of the crystallizing disk R as at S, and even while the disk is revolving water may be forced in against the filter paper on the sheet of cork Q, and in this way be carried by absorption to all the seeds on the disk Q. Fig. 3 shows the disk ready to rotate in a horizontal direction. Fig. 4 shows the end view of the frame at A and

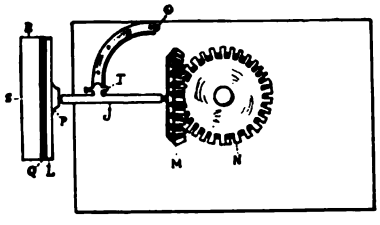


Fig. 4.

indicates how the disk may be rotated not only horizontally but vertically as well, or at any angle between the two by changing the position of the shaft in J by loosening and moving the clamp at T. This machine is also strong enough to carry any small flower pots with growing seedlings,

at any angle and at rapid speeds by using clamps to hold them in position.

As stated by Detmer, seedlings of the proper size when fastened on Q and rotated rapidly curve outwards. I have noticed a curving against the direction of motion in seedlings subjected by a stronger centrifugal machine than this exerting 4,400 gravities.

At U (Fig. 3) is another similarly arranged disk in case it is desired to run two at once at different angles. Here, however, the power is transmitted by a belt and cone pulleys, by means of which different speeds may be obtained. U may also be inclined at an angle by loosening or tightening V. At X, X¹ and Y the shaft is supported in journals. At W is a water wheel 50 cm. in diameter, and by using a very strong stream of water Z, a very high speed and ample power for the experiments here mentioned may be developed. Naturally the speed and power can be easily controlled by the force of the stream of water. By means of the cone-pulleys the machine may be driven by motor or other power.

IV. Apparatus for Growing Plants in Different Colored Lights.

This consists of a wooden box made perfectly tight to prevent the light from entering except at H, Fig. 6. It is 40 cm. long, 25 cm. wide and 25 cm. deep. Of course it is often advisable to use larger sizes of boxes, but the one here mentioned will serve as an illustration. The inside of the box is painted black and is provided with a base for holding

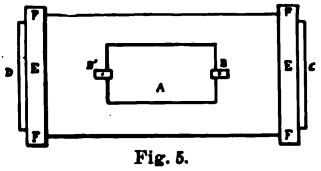


Fig. 5.

flower pots in any position. Each side of the box is provided with a door A, Fig. 5, which by means of the clamps B and B¹ may be removed so that the plant inside may be adjusted in the desired position, as regards the light entering at C or D, and measurements taken. The ends of the box are in the form of caps E (Fig. 5) which lap over the end at F so tightly that no light can enter.

Fig. 6 shows an end view of one of the caps E. In this figure there will be noticed a circular opening H, 15 cm. in diameter in the

center of the cap. Around H is a three-sided wooden frame I, on whose inner edge is a groove J, deep enough to receive one pane of glass. The

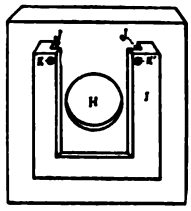


Fig. 6.

pane of glass used is 20 cm. square and must have exactly parallel surfaces. Light of any desired color may enter the box at H by putting in the groove J a glass plate which has been colored in the following way. To a 10 per cent. solution of gelatin add about .25 of a gram of the ordinary "Diamond Dye" of the color desired, while the gelatin is still hot and in solution. Stir well for a few minutes. Now place one of the glass plates in a perfectly horizontal position in a cool place and pour onto it a thin layer of the colored liquid gelatin. Let stand till the gelatin is solid. In this way colored plates of red, orange, green, blue or any other color or shade of color may be obtained. These colors have the additional advantage of being permanent. The screws K and K^1 hold the plates in the correct position in J. By having a number of colored plates any color in the box may be obtained by putting the plate of the desired color in J.

V. Photometer.

A simple form of photometer is shown in Fig. 7. It consists of a wooden base A, 110 cm. long and 25 cm. wide, on which stands a rectangular box B, 81 cm. long, 17.5 cm. wide, and 22 cm. high. This box B is

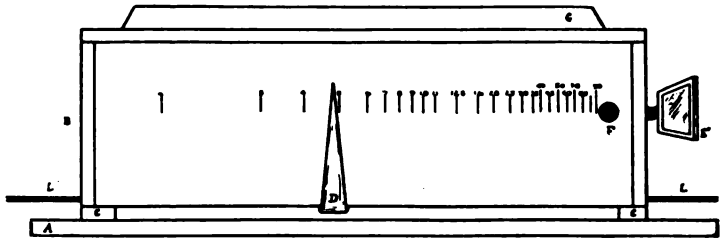


Fig. 7.

raised 1 cm. from A by a block of wood under each of the four corners as at C to allow the to-and-fro motion of the pointer D. The longitudinal opening under G and the base of D give ventilation. The figures on the side of B are accurately placed on the original apparatus and show the intensity of light in Hefner meter units. At E^1 is a mirror and at F a circular opening to a mirror inside. The interior view is shown in Fig. 8. Here A is the wooden base, C the wooden block supporting the box B. L and L^1 are strings by means of which the Hefner-Altneck amyl-acetate lamp is regulated in distances from the membrane K. This membrane consists simply of a circular piece of filter paper covering an opening in the center of the end of the box 7.5 cm. in diameter. In the center of the filter paper is a circular spot about three cm. in diameter, as in the ordinary Bunsen photometer. Each mirror E E^1 is 5 cm. long and 4 cm. wide and is inclined at an angle of about 45° to the filter paper membrane

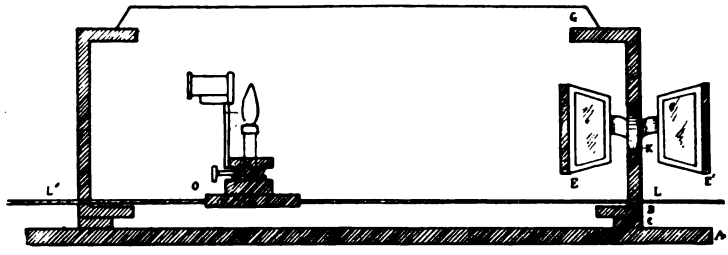


Fig. 8.

by means of the galvanized iron frame which supports it. The V-shaped top G is also composed of galvanized iron. This apparatus will show the intensity of light from 2 to 90 Hefner meter units. When it is desired to test the intensity of light between two and ninety Hefner units, draw the pointer D, opposite which inside the box the Hefner-Altneck amyl-acetate lamp is placed, by the string L towards the filter paper membrane. When the circular spot of paraffine on the filter paper almost disappears, then the light cast on the filter paper screen by the amyl-acetate lamp, and that in the room for example outside are equal. Noticing now the position of the pointer D, we notice that it points to or near some figure on the outside of the box. The number it points to indicates the intensity of light in Hefner meter units.

VI. Rheostat.

This piece of apparatus (Fig. 9) is 35 cm. long, 30 cm. high, and 15 cm. wide. It has a wooden frame A, over which the wire B is tightly stretched, the two sides being connected by the wire Q. The voltage, which, as here used, was a constant one, enters at M through the binding posts E E^1, and from this it passes through the wire B in the direction indicated by the arrow. The wire used was iron number 20 and in all 100 meters

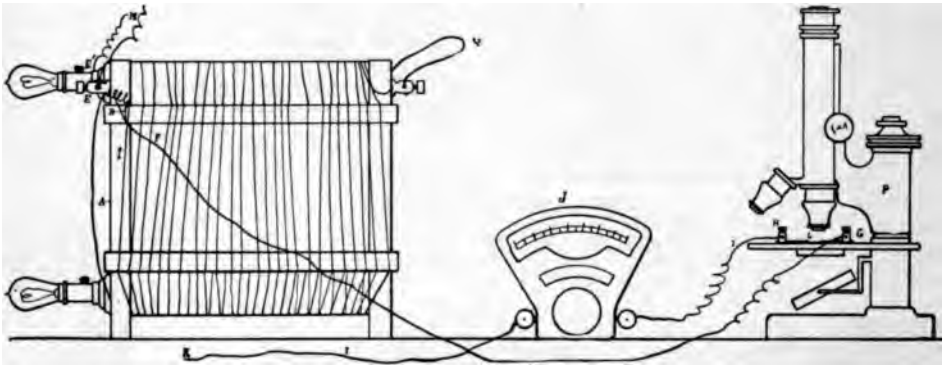


Fig. 9.

were used in making this machine to obtain if needed a high resistance so that by means of shunting any strength of current may be obtained. If an insulated wire F is connected with one post on an electric slide as at G, and the other post of this electric slide is joined to another insulated wire I, about the center of which is interpolated a milli-ampere meter J; then by shunting with the free end K of the wire I to the non-insulated wires B, an electric current if sufficiently strong will pass through a specimen laid on the slide at L under the microscope P. If at first the current at B is not strong enough, the free end of the wire K can be moved from B in the direction of the arrow till a current of the desired strength is obtained. The strength of the current will be registered by the meter J. In the experiment I tried, with 110 volts entering at E E^1, a current of .7 of a milli-ampere was sufficient to cause the movement in the protoplasm in Elodea cells to cease. It began again in 20 minutes. The lamps

Fig. 10.

may be used in the circuit in series to increase the resistance. Fig. 10 gives a view of a median vertical longitudinal section of the slide. It consists simply of a thick glass slide A, on which is a heavy layer of tin-foil B B^1, and on this a plate of copper C C^1, through which the binding posts G and H are screwed. This not only fastens B B^1 and C C^1 together, but fastens them to the glass slide A. The specimen is laid at L with its ends touching the ends of the tin-foil B B^1, on which the cover glass rests at OO^1.

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1905

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Indiana Academy of Science

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March 5, 1906.

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OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, April 19, 1906.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

WARREN BIGLER,
Auditor of State.

APRIL 20, 1906.

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Private Secretary.

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Secretary of State.

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AN ACT TO PROVIDE FOR THE PUBLICATION OF THE REPORTS AND PAPERS OF THE INDIANA ACADEMY OF SCIENCE.

[Approved March 11, 1895.]

Preamble.

WHEREAS, The Indiana Academy of Science, a chartered scientific association, has embodied in its constitution a provision that it will, upon the request of the Governor, or of the several departments of the State government, through the Governor, and through its council as an advisory body, assist in the direction and execution of any investigation within its province, without pecuniary gain to the Academy, provided only that the necessary expenses of such investigation are borne by the State; and,

WHEREAS, The reports of the meetings of said Academy, with the several papers read before it, have very great educational, industrial and economic value, and should be preserved in permanent form; and

WHEREAS, The Constitution of the State makes it the duty of the General Assembly to encourage by all suitable means intellectual, scientific and agricultural improvement; therefore,

Publication of the Reports of the Indiana Academy of Science.

SECTION 1. *Be it enacted by the General Assembly of the State of Indiana.* That hereafter the annual reports of the meetings of the Indiana Academy of Science, beginning with the report for the year 1894, including all papers of scientific or economic value, presented at such meetings, after they shall have been edited and prepared for publication as hereinafter provided, shall be published by and under the direction of the Commissioners of Public Printing and Binding.

Editing Reports.

SEC. 2. Said reports shall be edited and prepared for publication without expense to the State, by a corps of editors to be selected and appointed by the Indiana Academy of Science, who shall not, by reason of such services, have any claim against the State for compensation. The form, style of binding, paper, typography and manner and extent of illustration of such reports, shall be determined by the editors, subject to the approval of the Commissioners of Public Printing and Stationery. Not less than 1,500 nor more than 3,000 copies of each

Number of printed Reports.

of said reports shall be published, the size of the edition within said limits to be determined by the concurrent action of the editors and the Commissioners of Public Printing and Stationery: *Provided*, That not to exceed six hundred dollars ($600) shall be expended for such publication in any one year, and not to extend beyond 1896: *Provided*, That no sums shall be deemed to be appropriated for the year 1894.

Proviso.

SEC. 3. All except three hundred copies of each volume of said reports shall be placed in the custody of the State Librarian, who shall furnish one copy thereof to each public library in the State, one copy to each university, college or normal school in the State, one copy to each high school in the State having a library, which shall make application therefor, and one copy to such other institutions, societies or persons as may be designated by the Academy through its editors or its council. The remaining three hundred copies shall be turned over to the Academy to be disposed of as it may determine. In order to provide for the preservation of the same it shall be the duty of the Custodian of the State House to provide and place at the disposal of the Academy one of the unoccupied rooms of the State House, to be designated as the office of the Indiana Academy of Science, wherein said copies of said reports belonging to the Academy, together with the original manuscripts, drawings, etc., thereof can be safely kept, and he shall also equip the same with the necessary shelving and furniture.

Disposition of Reports.

SEC. 4. An emergency is hereby declared to exist for the immediate taking effect of this act, and it shall therefore take effect and be in force from and after its passage.

Emergency.

AN ACT FOR THE PROTECTION OF BIRDS, THEIR NESTS AND EGGS.

[Indiana Acts 1905.]

Birds.

SECTION 602. It shall be unlawful for any person to kill, trap or possess any wild bird, or to purchase or offer the same for sale, or to destroy the nests or the eggs of any wild bird except as otherwise provided in this section. But this section shall not apply to the following named game birds: The Anatidæ, commonly called swans, geese, brant, river and sea duck; the Rallidæ, commonly known as rails, coots, mudhens, and gallinules; the Limicolæ, commonly known as shore birds, plovers, surf birds, snipe, woodcock, sandpipers, tattlers and curlews; nor to English or European house sparrows, crows, hawks, or other birds of prey. Nor shall this section apply to any person taking birds or their nests or eggs for scientific purposes under permit, as provided in the next section. Any person violating the provisions of this section shall, upon conviction, be fined not less than ten dollars nor more than fifty dollars.

SEC. 603. Permits may be granted by the Commissioner of Fisheries and Game to any properly accredited person, permitting the holder thereof to collect birds, their nests or eggs for strictly scientific purposes. In order to obtain such permit the applicant for the same must present to said Commissioner written testimonials from two well-known scientific men certifying to the good character and fitness of said applicant to be entrusted with such privilege, and pay to said Commissioner one dollar therefor, and file with him a properly executed bond in the sum of two hundred dollars, payable to the State of Indiana, conditioned that he will obey the terms of such permit, and signed by at least two responsible citizens of the State as sureties. The bond may be forfeited and the permit revoked upon proof to the satisfaction of such Commissioner that the holder of such permit has killed any bird or taken the nests or eggs of any bird for any other purpose than that named in this section.

OFFICERS—1905-1906.

PRESIDENT,
ROBERT HESSLER.

VICE-PRESIDENT,
D. M. MOTTIER.

SECRETARY,
LYNN B. McMULLEN.

ASSISTANT SECRETARY,
J. H. RANSOM.

PRESS SECRETARY,
CHARLES R. CLARK.

TREASURER,
WILLIAM A. McBETH.

EXECUTIVE COMMITTEE.

ROBERT HESSLER,
D. M. MOTTIER,
LYNN B. McMULLEN,
J. H. RANSOM,
CHARLES R. CLARK,
WILLIAM A. McBETH,
JOHN S. WRIGHT,
CARL L. MEES,
WILLIS S. BLATCHLEY,
HARVEY W. WILEY,
M. B. THOMAS,
D. W. DENNIS,
C. H. EIGENMANN,
C. A. WALDO,
THOMAS GRAY,
STANLEY COULTER,
AMOS W. BUTLER,
W. A. NOYES,
J. C. ARTHUR,
J. L. CAMPBELL,*
O. P. HAY,
T. C. MENDENHALL,
JOHN C. BRANNER,
J. P. D. JOHN,
JOHN M. COULTER,
DAVID S. JORDAN.

CURATORS.

BOTANY ..... J. C. ARTHUR.
ICHTHYOLOGY ..... C. H. EIGENMANN.
HERPETOLOGY, MAMMALOGY, ORNITHOLOGY ..... AMOS W. BUTLER.
ENTOMOLOGY ..... W. S. BLATCHLEY.

*Deceased.

COMMITTEES, 1905-1906.

PROGRAM.

LYNN B. MCMULLEN, J. P. NAYLOR, W. J. MOENKHAUS.

MEMBERSHIP.

J. H. RANSOM, W. A. MCBETH.

NOMINATIONS.

G. W. BENTON, W. J. MOENKHAUS, W. S. BLATCHLEY.

AUDITING.

THOMAS GRAY, A. J. BIGNEY.

STATE LIBRARY.

G. W. BENTON, C. H. EIGENMANN, A. W. BUTLER,
W. S. BLATCHLEY, J. C. ARTHUR.

LEGISLATION FOR THE RESTRICTION OF WEEDS.

M. B. THOMAS, D. M. MOTTIER, C. C. DEAM.

PROPAGATION AND PROTECTION OF GAME AND FISH.

C. H. EIGENMANN, A. W. BUTLER, GLENN CULBERTSON.

EDITOR.

E. G. MARTIN, Purdue University, Lafayette.

DIRECTORS OF BIOLOGICAL SURVEY.

C. H. EIGENMANN, STANLEY COULTER, CHARLES R. DRYER, M. B. THOMAS, J. C. ARTHUR.

RELATIONS OF THE ACADEMY TO THE STATE.

C. A. WALDO, WILLIAM WATSON WOOLLEN, R. W. MCBRIDE, G. W. BENTON.

DISTRIBUTION OF THE PROCEEDINGS.

THOMAS GRAY, L. J. RETTGER, JOHN S. WRIGHT,
DONALDSON BODINE, D. W. DENNIS.

OFFICERS OF THE INDIANA ACADEMY OF SCIENCE.

	PRESIDENT.	SECRETARY.	ASST. SECRETARY.	PRESS SECRETARY.	TREASURER.
1885–6	David S. Jordan	Amos W. Butler			O. P. Jenkins.
1886–7	John M. Coulter	Amos W. Butler			O. P. Jenkins.
1887–8	J. P. D. John	Amos W. Butler			O. P. Jenkins.
1888–9	John C. Branner	Amos W. Butler			O. P. Jenkins.
1889–90	T. C. Mendenhall	Amos W. Butler			O. P. Jenkins.
1890–1	O. P. Hay	Amos W. Butler			O. P. Jenkins.
1891–2	J. L. Campbell	Amos W. Butler			C. A. Waldo.
1892–3	J. C. Arthur	Amos W. Butler	Stanley Coulter W. W. Norman		C. A. Waldo.
1893–4	W. A. Noyes	C. A. Waldo	W. W. Norman		W. P. Shannon.
1894–5	A. W. Butler	John S. Wright	A. J. Bigney		W. P. Shannon.
1895–6	Stanley Coulter	John S. Wright	A. J. Bigney		W. P. Shannon.
1896–7	Thomas Gray	John S. Wright	A. J. Bigney		W. P. Shannon.
1897–8	C. A. Waldo	John S. Wright	A. J. Bigney	Geo. W. Benton	J. T. Scovell.
1898–9	C. H. Eigenmann	John S. Wright	E. A. Schultze	Geo. W. Benton	J. T. Scovell.
1899–1900	D. W. Dennis	John S. Wright	E. A. Schultze	Geo. W. Benton	J. T. Scovell.
1900–1901	M. B. Thomas	John S. Wright	E. A. Schultze	Geo. W. Benton	J. T. Scovell.
1901–1902	Harvey W. Wiley	John S. Wright	Donaldson Bodine	Geo. W. Benton	J. T. Scovell.
1902–1903	W. S. Blatchley	John S. Wright	Donaldson Bodine	G. A. Abbott	W. A. McBeth.
1903–1904	C. L. Mees	John S. Wright	J. H. Ransom	G. A. Abbott	W. A. McBeth.
1904–1905	John S. Wright	Lynn B. M'Mullen	J. H. Ransom	G. A. Abbott	W. A. McBeth.
1905–1906	Robert Hessler	Lynn B. M'Mullen	J. H. Ransom	Charles R. Clark	W. A. McBeth.

CONSTITUTION.

ARTICLE I.

SECTION 1. This association shall be called the Indiana Academy of Science.

SEC. 2. The objects of this Academy shall be scientific research and the diffusion of knowledge concerning the various departments of science; to promote intercourse between men engaged in scientific work, especially in Indiana; to assist by investigation and discussion in developing and making known the material, educational and other resources and riches of the State; to arrange and prepare for publication such reports of investigation and discussions as may further the aims and objects of the Academy as set forth in these articles.

Whereas, The State has undertaken the publication of such proceedings, the Academy will, upon request of the Governor, or of one of the several departments of the State, through the Governor, act through its council as an advisory body in the direction and execution of any investigation within its province as stated. The necessary expenses incurred in the prosecution of such investigation are to be borne by the State; no pecuniary gain is to come to the Academy for its advice or direction of such investigation.

The regular proceedings of the Academy as published by the State shall become a public document.

ARTICLE II.

SECTION 1. Members of this Academy shall be honorary fellows, fellows, non-resident members or active members.

SEC. 2. Any person engaged in any department of scientific work, or in original research in any department of science, shall be eligible to active membership. Active members may be annual or life members. Annual members may be elected at any meeting of the Academy; they shall sign the constitution, pay an admission fee of two dollars, and

thereafter an annual fee of one dollar. Any person who shall at one time contribute fifty dollars to the funds of this Academy may be elected a life member of the Academy, free of assessment. Non-resident members may be elected from those who have been active members but who have removed from the State. In any case, a three-fourths vote of the members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on application for membership, who shall consider such application and report to the Academy before the election.

SEC. 3. The members who are actively engaged in scientific work, who have recognized standing as scientific men, and who have been members of the Academy at least one year, may be recommended for nomination for election as fellows by three fellows or members personally acquainted with their work and character. Of members so nominated a number not exceeding five in one year may, on recommendation of the Executive Committee, be elected as fellows. At the meeting at which this is adopted, the members of the Executive Committee for 1894 and fifteen others shall be elected fellows, and those now honorary members shall become honorary fellows. Honorary fellows may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case a three-fourths vote of the members present shall elect.

ARTICLE III.

SECTION 1. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall hold office one year. They shall consist of a President, Vice-President, Secretary, Assistant Secretary, Press Secretary and Treasurer, who shall perform the duties usually pertaining to their respective offices, and in addition, with the ex-Presidents of the Academy, shall constitute an Executive Committee. The President shall, at each annual meeting, appoint two members to be a committee, which shall prepare the programs and have charge of the arrangements for all meetings for one year.

SEC. 2. The annual meeting of this Academy shall be held in the city of Indianapolis within the week following Christmas of each year, unless otherwise ordered by the Executive Committee. There shall also be a summer meeting at such time and place as may be decided upon

by the Executive Committee. Other meetings may be called at the discretion of the Executive Committee. The past Presidents, together with the officers and Executive Committee, shall constitute the Council of the Academy, and represent it in the transaction of any necessary business not especially provided for in this constitution, in the interim between general meetings.

SEC. 3. This constitution may be altered or amended at any annual meeting by a three-fourths majority of the attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

BY-LAWS.

1. On motion, any special department of science shall be assigned to a curator, whose duty it shall be, with the assistance of the other members interested in the same department, to endeavor to advance knowledge in that particular department. Each curator shall report at such time and place as the Academy shall direct. These reports shall include a brief summary of the progress of the department during the year preceding the presentation of the report.

2. The President shall deliver a public address on the morning of one of the days of the meeting at the expiration of his term of office.

3. The Press Secretary shall attend to the securing of proper newspaper reports of the meetings and assist the Secretary.

4. No special meeting of the Academy shall be held without a notice of the same having been sent to the address of each member at least fifteen days before such meeting.

5. No bill against the Academy shall be paid without an order signed by the President and countersigned by the Secretary.

6. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the Treasurer, shall have their names stricken from the roll.

7. Ten members shall constitute a quorum for the transaction of business.

MEMBERS.

FELLOWS.

R. J. Aley	*1898	Bloomington.
Frank M. Andrews	1904	Bloomington.
J. C. Arthur	1893	Lafayette.
George W. Benton	1896	Indianapolis.
A. J. Bigney	1897	Moore's Hill.
A. W. Bitting	1897	West Lafayette.
Katherine Golden Bitting	1895	Lafayette.
Donaldson Bodine	1899	Crawfordsville.
W. S. Blatchley	1893	Indianapolis.
H. L. Bruner	1899	Irvington.
Severance Burrage	1898	Lafayette.
A. W. Butler	1893	Indianapolis.
J. L. Campbell**	1893	Crawfordsville.
Mel. T. Cook	1902	Santiago, Cuba.
John M. Coulter	1893	Chicago, Ill.
Stanley Coulter	1893	Lafayette.
Glenn Culbertson	1899	Hanover.
D. W. Dennis	1895	Richmond.
C. R. Dryer	1897	Terre Haute.
C. H. Eigenmann	1893	Bloomington.
Percy Norton Evans	1901	West Lafayette.
A. L. Foley	1897	Bloomington.
M. J. Golden	1899	Lafayette.
W. F. M. Goss	1893	Lafayette.
Thomas Gray	1893	Terre Haute.
A. S. Hathaway	1895	Terre Haute.
W. K. Hatt	1902	Lafayette.
Robert Hessler	1899	Logansport.
H. A. Huston	1893	Lafayette.
Edwin S. Johonnatt	1904	Terre Haute.
Arthur Kendrick	1898	Terre Haute.
Robert E. Lyons	1896	Bloomington.
W. A. McBeth	1904	Terre Haute.

*Date of election.
**Deceased.

V. F. Marsters	*1893	Bloomington.
C. L. Mees	1894	Terre Haute.
J. A. Miller	1904	Bloomington.
W. J. Moenkhaus	1901	Bloomington.
Joseph Moore	1896	Richmond.
D. M. Mottier	1893	Bloomington.
J. P. Naylor	1903	Greencastle.
W. A. Noyes	1893	Washington, D. C.
J. H. Ransom	1902	Lafayette.
L. J. Rettger	1896	Terre Haute.
J. T. Scovell	1894	Terre Haute.
Alex Smith	1893	Chicago, Ill.
W. E. Stone	1893	Lafayette.
Joseph Swain	1898	Swarthmore, Pa.
M. B. Thomas	1893	Crawfordsville.
C. A. Waldo	1893	Lafayette.
F. M. Webster	1894	Champaign, Ill.
Jacob Westlund	1904	Lafayette.
H. W. Wiley	1895	Washington, D. C.
John S. Wright	1894	Indianapolis.

NON-RESIDENT MEMBERS.

George H. Ashley	Charleston, S. C.
M. A. Brannon	Grand Forks, N. D.
J. C. Branner	Stanford University, Cal.
D. H. Campbell	Stanford University, Cal.
A. Wilmer Duff	Worcester, Mass.
B. W. Everman	Washington, D. C.
Charles H. Gilbert	Stanford University, Cal.
C. W. Green	Columbia, Mo.
C. W. Hargitt	Syracuse, N. Y.
O. P. Hay	New York City.
Edward Hughes	Stockton, Cal.
O. P. Jenkins	Stanford University, Cal.
D. S. Jordan	Stanford University, Cal.
J. S. Kingsley	Tufts College, Mass.

*Date of election.

D. T. MacDougal.....Bronx Park, New York City.
T. C. Mendenhall.....Worcester, Mass.
Alfred Springer.....Cincinnati, Ohio.
L. M. Underwood.....New York City.
Robert B. Warder.....Washington, D. C.
Ernest Walker.....Clemson College, S. C.

ACTIVE MEMBERS.

George Abbott.....Indianapolis.
George C. Ashman.....Frankfort.
Edward Ayres.....Lafayette.
H. F. Bain.....Urbana, Ill.
Frank Tarkington Baker.....Indianapolis.
Edward Hugh Bangs.....Indianapolis.
Walter D. Baker.....Indianapolis.
Arthur M. Banta.....Franklin.
Harry E. Barnard.....Indianapolis.
Victor Hugo Barnett.....Indianapolis.
J. W. Beede.....Bloomington.
Harry Eldridge Bishop.....Indianapolis
Lester Black.....Bloomington.
William N. Blanchard.....Greencastle.
Edwin M. Blake.....Lafayette.
Lee F. Bennett.....Valparaiso.
Charles S. Bond.....Richmond.
Fred. J. Breeze.....Delphi.
E. M. Bruce.....Weston, Oregon.
Lewis Clinton Carson.....Bloomington.
Herman S. Chamberlain.....Indianapolis.
E. J. Chansler.....Bicknell.
Otto O. Clayton.....Geneva.
Howard W. Clark.....Chicago, Ill.
H. M. Clem.....Bloomington.
George Clements.....Crawfordsville.
Charles Clickener.....Silverwood, R. D. No. 1.
Charles A. Coffey.....Petersburg.
Wilber A. Cogshall.....Bloomington.

Ulysses O. Cox ..... Terre Haute.
William Clifford Cox ..... Columbus.
J. A. Cragwall ..... Crawfordsville.
Albert B. Crow ..... Charleston, Ill.
M. E. Crowell ..... Franklin.
Edward Roscoe Cumings ..... Bloomington.
Alida M. Cunningham ..... Alexandria.
Lorenzo E. Daniels ..... Laporte.
H. J. Davidson ..... Baltimore, Md.
Charles C. Deam ..... Bluffton.
Martha Doan ..... Westfield.
J. P. Dolan ..... Syracuse.
Benjamin W. Douglas ..... Indianapolis.
Herman B. Dorner ..... Lafayette.
Hans Duden ..... Indianapolis.
Arthur E. Dunn ..... Logansport.
Herbert A. Dunn ..... Logansport.
E. G. Eberhardt ..... Indianapolis.
Frank R. Eldred ..... Indianapolis.
M. N. Elrod ..... Columbus.
Samuel G. Evans ..... Evansville.
William P. Felver ..... Logansport.
Carlton G. Ferris ..... Big Rapids, Mich.
E. M. Fisher ..... Urmeyville.
Wilbur A. Fiske ..... Richmond.
W. B. Fletcher ..... Indianapolis.
Austin Funk ..... New Albany.
John D. Gabel ..... Montpelier.
Andrew W. Gamble ..... Logansport.
Charles W. Garrett ..... Pittsburg, Pa.
Robert G. Gillum ..... Terre Haute.
Wilmer Jacob Gittner ..... Anderson.
Vernon Gould ..... Rochester.
Walter L. Hahn ..... Washington, D. C.
Mary T. Harman ..... Odon.
Victor Hendricks ..... Indianapolis.
John P. Hetherington ..... Logansport.
Mary A. Hickman ..... Greencastle.

John E. Higdon ..... Indianapolis.
Frank R. Higgins ..... Terre Haute.
S. Bella Hilands ..... Madison.
John J. Hildebrandt ..... Logansport.
G. E. Hoffman ..... Logansport.
J. D. Hoffman ..... Lafayette.
Allen D. Hole ..... Richmond.
Lucius M. Hubbard ..... South Bend.
John N. Hurty ..... Indianapolis.
C. F. Jackson ..... Greencastle.
Dennis Emerson Jackson ..... Bloomington.
Alex. Johnson ..... Ft. Wayne.
Ernest E. Jones ..... Kokomo.
Wm. J. Jones, Jr ..... West Lafayette.
Chancey Juday ..... Boulder, Colo.
O. L. Kelso ..... Terre Haute.
Norton A. Kent ..... Crawfordsville.
Frank D. Kern ..... Lafayette.
Charles T. Knipp ..... Urbana, Ill.
Henry H. Lane ..... Lebanon.
William E. Lawrence ..... Richmond.
V. H. Lockwood ..... Indianapolis.
Robert Wesley McBride ..... Indianapolis.
Rousseau McClellan ..... Indianapolis.
Richard C. McClaskey ..... Terre Haute.
N. E. McIndoo ..... Bloomington.
Lynn B. McMullen ..... Indianapolis.
Edward G. Mahin ..... West Lafayette.
James E. Manchester ..... Vincennes.
Wilfred H. Manwaring ..... Bloomington.
E. G. Martin ..... Lafayette.
Thomas Edward Mason ..... Hodgenville, Ky.
Clark Mick ..... Berkley, Cal.
W. G. Middleton ..... Richmond.
G. Rudolph Miller ..... Indianapolis.
H. T. Montgomery ..... South Bend.
Richard Bishop Moore ..... Indianapolis.
Walter P. Morgan ..... Terre Haute.

Fred Mutchler ..... Terre Haute.
Charles E. Newlin ..... Irvington.
John Newlin ..... West Lafayette.
John F. Newsom ..... Stanford University, Cal.
R. W. Noble ..... Chicago, Ill.
Andrew Fletcher Ogle ..... Bloomington.
D. A. Owen ..... Franklin.
Ferd Payne ..... Bloomington.
Rollo J. Peirce ..... Indianapolis.
Ralph B. Polk ..... Greenwood.
James A. Price ..... Ft. Wayne.
Frank A. Preston ..... Indianapolis.
A. H. Purdue ..... Fayetteville, Ark.
Rolla R. Ramsey ..... Bloomington.
Ryland Ratliff ..... Danville.
Walter S. Ratliff ..... Richmond.
Albert B. Reagan ..... Mora, Wash.
Allen J. Reynolds ..... Emporia, Kansas.
Giles E. Ripley ..... Decorah, Iowa.
George L. Roberts ..... Muncie.
D. A. Rothrock ..... Bloomington.
John F. Schnaible ..... Lafayette.
E. A. Schultze ..... Ft. Wayne.
Will Scott ..... Terre Haute.
Charles Wm. Shannon ..... Bloomington.
John W. Shepherd ..... Terre Haute.
Claude Siebenthal ..... Indianapolis.
Fred Sillery ..... Indianapolis.
J. R. Slonaker ..... Madison, Wis.
Essie Alma Smith ..... Bloomington.
C. Piper Smith ..... Leland Stanford, Cal.
Retta E. Spears ..... Elkhart.
J. M. Stoddard ..... Indianapolis.
Charles F. Stegmaier ..... Greensburg.
William Stewart ..... Burlington, Vt.
William B. Streeter ..... Indianapolis.
Frank B. Taylor ..... Ft. Wayne.
Albert W. Thompson ..... Owensville.

J. F. Thompson ..... Richmond.
C. H. Underwood ..... Indianapolis.
A. L. Treadwell ..... Oxford, Ohio.
Daniel J. Troyer ..... Goshen.
A. B. Ulrey ..... North Manchester.
W. B. Van Gorder ..... Worthington.
Arthur C. Veatch ..... Rockport.
H. S. Voorhees ..... Ft. Wayne.
J. H. Voris ..... Duluth, Minn.
Frank B. Wade ..... Indianapolis.
Lewis Clinton Ward ..... Huntington.
Daniel T. Weir ..... Indianapolis.
B. C. Waldemaier ..... West Lafayette.
Fred C. Whitcomb ..... Delphi.
William M. Whitten ..... South Bend.
Albert F. Wiancko ..... Lafayette.
Neil H. Williams ..... Terre Haute.
Guy West Wilson ..... Lafayette.
William Watson Woollen ..... Indianapolis.
Herbert Milton Woolen ..... Indianapolis.
J. F. Woolsey ..... Indianapolis.
Lucy Youse ..... Palo Alto, Cal.
Charles Zeleny ..... Bloomington.

Fellows	52
Non-resident members	20
Active members	166
Total	238

NOTE.—For list of Foreign Correspondents, see Proceedings of 1901.

LIST OF PAPERS APPEARING ON THE PROGRAM OF THE TWENTY-FIRST ANNUAL MEETING,

Held in Shortridge High School, December 1, 1905.

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*President's Address—A Consideration of Certain Investigations Needed in Pharmacology ..... John S. Wright

GENERAL.

*1. Some Scientific Aspects of Tea Drinking, 5m ..... Frank B. Wade
2. The Lummi Indians, 10m ..... Albert B. Reagan
3. Radium and Radio-Activity, 10m ..... Ryland Ratliff
*4. The Radium Clock, 5m ..... Rolla R. Ramsey
*5. The Use of Peat as Fuel, 15m ..... Benj. W. Douglass
6. The Molecular Forces in Gelatine, 5m ..... Arthur L. Foley
*7. The Chronic Ill Health of Darwin, Huxley, Spencer and George Eliot, 20m., (abstract) ..... Robert Hessler
*8. The Wood Pulp Industry, 10m ..... M. D. Renkenberger
9. Buzzard's Roost, 10m ..... William Watson Woollen
10. Thorium and its Disintegration Products, 20m ..... Richard D. Moore
*11. An Account of a Buzzard's Nest with Photographs of the Young up to the Seventy-fourth Day, When They Left the Nest, 10m ..... D. W. Dennis
*12. The Solar Eclipse of 1905, 20m. (lantern) ..... John A. Miller

PHYSICS, CHEMISTRY, GEOLOGY AND MATHEMATICS.

*13. Irrelevant Factors in the Bitangentals of Plane Algebraic Curves, 10m. Ulysses S. Hanna
*14. On the Weathering of the Subcarboniferous Limestone in the Non-Glaciated Area of Southern Indiana, 10m ..... E. R. Cummings
*15. Action of Calcium Chloride Solution on Glass, 5m ..... P. N. Evans
16. The Age of the Red-Beds of Oklahoma Territory and the "Panhandle" of Texas, East of the Staked Plains, 10m ..... J. W. Beede
17. Methods of Collecting Fossils, 10m ..... J. W. Beede
*18. Equivalent-Weight-Determination Apparatus, 5m ..... James H. Ransom
19. Result of Heating a Mixture of Manganese Dioxide and Ammonium Nitrate, 10m ..... James H. Ransom
*20. Studies in Catalysis, 10m ..... James H. Ransom
21. Comparison of the Faunas of the Salem Limestone at Ellettsville, Big Creek and Romona, 10m ..... A. W. Thompson
*22. Effect of Radium on Electrolytic Conductivity, 5m ..... Ryland Ratliff
23. Summary of Glacial Literature Relating to Glacial Deposits, 10m ... Albert B. Reagan
24. Some Geological Studies on Northwestern Washington and Adjacent British Territory, 10m ..... Albert B. Reagan
*25. A Simple Method of Measuring Electrolytic Resistance, 5m ..... Rolla R. Ramsey
*26. Some Peculiarities of Electric Sparks Across Short Spark-Gaps, 10m Rolla R. Ramsey
*27. Gas Burners and Standards of Candle Power, 5m .. Rolla R. Ramsey and Hiromitsu Oi
28. Determination of the Latitude of Flower Observatory, 10m ..... W. E. Howard
29. Electromagnetic Induction in Various Conductors and Electrolytes, II, 10m ..... Arthur L. Foley

30. On the Use of a Copper, Aluminum, Manganese Alloy as a Core in the Rutherford-Marconi Magnetic Detector, 10m ..... Arthur L. Foley
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*51. The Regeneration of a Centema-like Organ in Place of the Momentary Eye of the Blind Crayfish, 10m. (abstract) ..... Charles Zeleny
52. The Habitat and Life History of the Cuban Blind Fishes (lantern), 15m., C. H. Eigenmann
53. The Origin and Dispersion of South American Fresh Water Fishes (lantern), 30m ..... C. H. Eigenmann
54. Portraits of Indiana Fishes (lantern), 10m ..... Lester F. Black
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*74. An Occurrence of Kirtland's Warbler, 3m ..... Loren C. Petry
*75. Nitrifying Bacteria, 10m ..... A. J. Bigney
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81. Spore-Like Bodies in Oscillaria sp., 10m ..... Severance Burrage
82. The Oaks of Indiana, 15m ..... Stanley Coulter
*83. The Leesburg Swamp, 10m ..... Will Scott
84. Notes on the Crayfish of Wells County, Indiana, 5m ..... E. B. Williamson
*85. Note on the Recurrence of Brood V ..... Walter L. Hahn

*Papers marked with an asterisk appear in the following pages.

PRESIDENT'S ADDRESS.

A CONSIDERATION OF CERTAIN NEEDED INVESTIGATIONS IN PHARMACOLOGY.

By John S. Wright.

(Abstract.)

Under this title the term pharmacology is not used in its restricted sense, meaning pharmaco-dynamics only, but is employed to embrace the botany, chemistry and physiological action of drugs. The suggestions for needed investigations are the result of a critical study of the records of about four hundred drugs used in medicine at present.

In order to arrive at some general conclusions concerning existing knowledge of the commonly used organic drugs, those studied were reviewed, marked and classified in eight groups based on the extent to which they have been investigated, botanically, chemically and physiologically, as follows:

CLASSES BASED ON THE EXTENT OF CHEMICAL KNOWLEDGE.

1. Drugs whose chemical constituents and active principles are regarded as well known—276, or approximately 70 per cent.
2. Drugs whose chemical constituents and active principles are but partially determined—100, or approximately 25 per cent.
3. Drugs whose chemical constituents and active principles are undetermined—25, or approximately 6 per cent.

CLASSES BASED ON THE EXTENT OF KNOWLEDGE OF PHYSIOLOGICAL ACTION.

4. Drugs whose physiological action is well known, or which have been subjects of systematic investigations—175, or approximately 43 per cent.

5. Drugs whose physiological action is partially understood, chiefly through careful clinical reports—140, or approximately 35 per cent.
6. Drugs used empirically or employed for "reputed" action, no satisfactory records of scientific experiments or chemical investigations—82, or approximately 20 per cent.
7. Drugs employed primarily for purposes other than definite physiological effects, such as flavors, colors, etc. (some not used internally at present)—9, or approximately 2 per cent.

* * * * *

8. Drugs of obscure or unknown origin—2, or approximately ½ per cent.

These groups or classes are not marked by hard and fast boundary lines, and perhaps no two students would agree wholly to any single classification, as the personal equation enters largely into the work. A drug which one might regard as sufficiently known chemically and physiologically to be classed as "well known," another would rank as "partially determined," and similar differences of opinion will arise respecting other points involved, so that the classification given above is not offered as an exact record of the knowledge of the representative drugs, but rather as the author's estimation of that knowledge, and as said at the outset, it is given as a basis or reason for the proposal of certain lines of botanical, chemical and physiological investigation.

Lest there be misconception regarding the use of little-known drugs by physicians, it should be remembered that 70 per cent. of all drugs reviewed have been investigated chemically; that 43 per cent. have been subjected to systematic physiological experiments, and that the physiological action of 35 per cent. more is partially understood. Thus it seems that from 70 to 78 per cent. are employed on the basis of demonstrated value. Furthermore, it should be remembered that the 70 to 78 per cent. in number constitutes a very large percentage of the volume of drugs prescribed. While no statistics are available, in the opinion of the author it is over 90 per cent. of the total quantity used.

The Proceedings of the Indiana Academy of Science are primarily intended to disseminate information of special service in the development of the State and its resources. As space is limited, it is necessary to restrict further report of this address to the tables below showing the state of knowledge of drug plants of Indiana.

Indiana Plants Yielding Drugs.

In order that the student may have a wider range in selecting a subject for study this list has been enlarged to include introduced and cultivated species, also a few plants foreign to our soil, but which may be cultivated in gardens for supplying laboratory material. The native species and the introduced and cultivated species are unmarked; those of the last class are indicated by an asterisk (*).

Chemical constituents, active principles and physiological action regarded as well known:

Allium sativum Linn. Garlic, bulb.
*Althæa officianalis Linn. Marshmallow, root.
Anthemis nobilis Linn. Roman chamomile, inflorescence.
Apocynum cannabinum Linn. Black Indian hemp, root.
Arctostaphylos Uva Ursi (Linn.) Sprengel. Uva Ursi, leaves.
Arisæma triphyllum (Linn.) Torr. Indian turnip, tuber.
Artemisia Absinthium Linn. Wormwood, leaves and inflorescence.
*Atropa Belladonna Linn. Belladonna, leaves and root.
Carum Carvi Linn. Caraway seed, fruit.
*Carum Petroselinum Benth. Parsley, root and fruit.
Cercis Canadensis Linn. Judas tree, bark.
Chenopodium anthelminticum Linn. American wormseed, seed.
Chimaphila umbellata (Linn.) Nutt. Pipsissewa, herb.
*Claviceps purpurea (Fries) Tulasne. Ergot, sclerotium.
Cochlearia Armoracia Linn. Horseradish, root.
Conium maculatum Linn. Conium, fruit.
Convallaria majalis Linn. Lilly of the Valley, rhizome and rootlets.
Coptis trifolia (Linn.) Salisb. Gold thread, herb.
Delphinium consolida Linn. Larkspur, seed.
*Digitalis purpurea Linn. Digitalis, leaves, flowers and seed.
*Dryopteris Filix-mas Schott and D. Marginalis, Gray. Male fern, rhizome.
Epigea repens Linn. Gravel plant, herb.
Euonymus atropurpureus Jacq. Wahoo, bark.
Gaultheria procumbens Linn. Wintergreen, leaves and inflorescence.
*Gentiana lutea Linn. Gentian, root.
Geranium maculatum Linn. Cranesbill, rhizome.
Humulus Lupulus Linn. Hops, inflorescence.

*Hyoscyamus niger Linn. Henbane, leaves and inflorescence.
Juniperus communis Linn. Juniper berries, fruit.
Lactuca Canadensis Linn. Wild lettuce, leaves and inflorescence.
Lobelia inflata Linn. Lobelia, herb and seed.
Menispermum Canadensis Linn. Yellow parilla, rhizome and roots.
Mentha piperita Linn. Peppermint, leaves and inflorescence.
Monarda fistulosa Linn. Wild bergamot, leaves and inflorescence.
Phytolacca decandra Linn. Poke root and berries.
Podophyllum peltatum Linn. Mandrake, rhizome and roots.
Prunus serotina Ehrh. Cherry, bark.
Quercus alba Linn. White oak, bark.
*Ricinus communis Linn. Castor bean, seed and leaves.
Rubus villosus Aiton R. Canadensis, Linn. and R. trivalis, Michx. Blackberry, root bark.
*Salvia officinalis Linn. Sage, herb.
Sanguinaria Canadensis Linn. Blood root, rhizome.
Sassafras variifolium (Salisbury) O. Kuntze. Sassafras bark, root, bark.
Satureja hortensis Linn. Summer savory, herb.
Taraxacum officinale Weber. Dandelion, root.
Thuja occidentalis Linn. Arbor vitae, leaves.
Thymus vulgaris Linn. Thyme.
Tsuga Canadensis (Linn.) Carr. Hemlock, bark.
Ustilago Maydis Leveille. Ustilago, entire fungous plant.
*Valeriana officinalis Linn. Valerian, rhizome and rootlets.
*Veratrum album Linn. White hellebore, rhizome and rootlets.
Veratrum viride Aiton. Veratrum, rhizome and rootlets.

Chemical constitutents but partially determined; physiological action fairly well known:

*Cactus grandiflorus Linn. Cactus grandiflorus, branches.
Cannabis sativa Linn. var. Americana. American hemp, inflorescence.
Spigelia Marylandica Linn. Pink root, rhizome and rootlets.

Chemical constituents regarded as well known; physiological action not systematically investigated or well understood:

Acorus Calamus Linn. Calamus, rhizome.
Æsculus Hippocastanum Linn. Horse chestnut, bark and seed.

Agropyrum repens (Linn.) Beauv. Couch grass, rhizome.

Aralia racemosa Linn. Spikenard, root.

Arctium Lappa Linn. and some other species of Arctium, Burdock, root and seed.

Asarum Canadense Linn. Canada snake root, rhizome.

Asclepias incarnata Linn. White Indian hemp, root.

Beberis vulgaris Linn. Barberry, bark.

Castanea dentata (Marsh) Sudworth. Chestnut, leaves.

Caulophllum thalictroides (Linn.) Michx. Blue cohosh, rhizome and rootlets.

Ceanothus Americanus Linn. Jersey tea, leaves.

Chelidonium majus Linn. Garden celandine.

Cornus circinata L. Heritier. Green osier, bark.

Cornus florida Linn. Dogwood, bark.

Cypripedium pubescens Swartz and C. parviflorum Salisbury, Ladies' Slipper, rhizome and rootlets.

Epilobium angustifolium Linn. Willow herb, herb.

Eupatorium perfoliatum Linn. Boneset, leaves and inflorescence.

Eupatorium purpureum Linn. Queen of the meadow, rhizome and rootlets.

Galium Aparine Linn. Cleavers, herb.

Helianthus annuus Linn. Sunflower seed.

Hepatica triloba Chaix. Liverwort, herb.

Inula Helenium Linn. Elecampane, rhizome and rootlets.

Heuchera Americana Linn. Alum root, rhizome.

*Kalmia angustifolia Linn. Sheep laurel, leaves.

Liriodendron Tulipifera Linn. Tulip tree, younger bark.

Marrubium vulgare Linn. Horehound, herb.

Matricaria Chamomilla Linn. German chamomile, flowers.

Melissa officinalis Linn. Lemon balm, herb.

Penthorum sedoides Linn. Virginia stonecrop, leaves and inflorescence.

Phoradendron flavescens (Pursh.) Nutt. Mistletoe, leaves and branches.

Phytolacca decandra Linn. Poke berries.

Polygonatum biflorum (Walt.) Ell. Solomon's seal, rhizome.

Polygonum hydropiper Linn. P. hydropiperoides Mich. and P. punctatum Ell. Water pepper, herb.

Populus Balsamifera candicans (Ait.) Gray. Balm Gilead, buds.

Ptelea trifoliata Linn. Wafer ash, root bark.

Rhus glabra Linn. Sumach berries.
Rhus radicans Linn. Poison oak, leaves.
Rumex crispus Linn and some other species of Rumex. Yellow dock, root.
Salix alba Linn. White willow, bark.
Salix nigra Marsh. Black willow, buds and bark.
Sambucus Canadensis Linn. Elder flowers.
Saponaria officinalis Linn. Soapwort, herb.
Scrophularia nodosa var. Marylandica A. Gray. Figwort, herb.
Solanum Dulcamara Linn. Bittersweet, twigs.
Symphtum officinale Linn. Comfrey, root.
Trifolium pratense Linn. Clover (red), tops.
Viola Tricolor Linn. Pansy, herb.
Xanthoxylum Americanum Miller. Prickly ash, bark.
Zea Mays Linn. Cornsilk.

Chemical constituents but partially determined; physiological action not systematically investigated or well understood:

Ailanthus glandulosa Desf. Ailanthus, bark.
Aletris farinosa Linn. Unicorn root, rhizome.
Borago officinalis Linn. Borage, herb.
*Cactus Grandiflorus Linn. Cactus grandiflorus, succulent branches.
Castalia odorata (Dryander) Woods and Wood. White pond lily, rhizome.
Cimicifuga racemosa (Linn.) Nutt. Black cohosh, rhizome and rootlets.
Citrullus vulgaris Schrader. Water melon seed.
Dioscorea villosa Linn. Wild yam, rhizome.
Erigeron Canadensis Linn. Flebane, leaves and inflorescence.
Fraxinus Americana Linn. American White ash, bark.
Hamamelis Virginiana Linn. Witch hazel, leaves and bark.
Iris versicolor Linn. Blue flag, rhizome.
Juglans cinerea Linn. Butternut-root, bark.
Juglans nigra Linn. Black walnut, leaves.
Larix laricina (Duroi) Koch. Tamarac, bark deprived of corky layer.
Leonurus Cardiaca Linn. Motherwort, herb.
Liquidambar Styraciflua Linn. Sweet gum, inner bark.

Lycopersicum esculentum Miller. Tomato, herb.

Lycopus Virginicus Linn. Bugleweed, herb.

Nepeta Cataria Linn. Catnep, herb.

Œnonthera biennis Linn. Evening primrose, herb.

*Œnanthe Phellandrium Lam. Water fennel, seed and fruit.

*Pæonia officinalis Linn. Peony, rhizome.

Panax quinquefolium Linn. Ginseng, root.

Populus tremuloides Michx. and P. alba, Linn. White poplar, bark.

Prunus Persicaria (Linn.) Seibold and Zuccarina. Peach leaves.

*Ricinus communis Linn. Castor leaves.

Salix nigra, Marsh. Black willow, buds.

Solanum Carolinense Linn. Horse-nettle, berries and root.

Solidago Canadensis Linn. Solidago Canadensis, leaves and inflorescence.

Urtica dioica Linn. Nettle root.

Verbascum Thapsus Linn. Mullein leaves.

Viburnum Prunifolium Linn. Black haw, bark.

Chemical constituents regarded well known; physiological action uninvestigated:

Achillea Millefolium Linn. Yarrow, leaves and inflorescence.

Agropyrum graveolens Linn. Celery seed.

Asclepias Syriaca Linn. Silkweed, root.

Asparagus officinalis Linn. Asparagus, root.

*Carthamnus tinctorius Willd. American saffron, flowers.

Chrysanthemum Parthenium (Linn.) Pers. Feverfew, herb.

Dicentra Canadensis D. C. Turkey corn, tubers.

Equisetum hyemale Linn. Equisetum hyemale, herb.

Hydrangea arborescens Linn. Hydrangea, roots.

Hypericum perforatum Linn. Johnswort, herb.

Mitchella repens Linn. Squaw vine, herb.

Sabbatia angularis (Linn.) Pursh. Centaury, herb.

Solidago odora Aiton. Golden rod, leaves and inflorescence.

Chemical constituents but partially determined; physiological action uninvestigated:

Adiantum pedatum Linn. Maiden hair fern, frond.

Agrimonia Eupatoria Walt. Agrimony, herb.

Ampelopsis quinquefolia Michx. American ivy, bark and small twigs.
Aralia nudicaulis Linn. American sarsaparilla, root.
Avena sativa Linn. Avena sativa, heads.
Calendula officinalis Linn. Calendula flowers and calendula herb.
Capsella Bursa-Pastoris Moench. Shepherd's purse, herb.
Celastrus scandens Linn. False bittersweet, bark.
Chelone glabra Linn. Balmony, herb.
Collinsonia Canadensis Linn. Stoneroot, rhizome.
Epiphegus Virginiana (Linn.) Bart. Beech drops, herb.
Gnaphalium obtusifolium Linn. Life everlasting, herb.
Juglans nigra Linn. Black walnut hulls, epicarp.
Lacinaria spicata (Linn.) Kuntze. Button snake root, tuber.
Nepeta Glechoma Benth. Ground ivy, herb.
Ostrya Virginiana (Mill) Willd. Ironwood, heart wood.
Pimpinella Saxifraga Linn. Saxifrage, root.
Plantago major Linn. Plantain leaves.
Polymnia Uvedalia Linn. Bearsfoot, root.
Scutellaria lateriflora Linn. Scullcap, herb.
Spirea tomentosa Linn. Hard hack, leaves, etc.
Symplocarpus foetidus Nutt. Skunk cabbage, root stock.
Trillium erectum Linn. Bethroot, rhizome.
Viola pedata Linn. Violet herb, leaves, etc.

Chemical constituents undetermined; physiological action not systematically investigated or well understood:

Trifolium repens Linn. White clover, inflorescence.
Xanthoxylum Americanum Miller. Prickly ash, berries.

Chemical constituents undetermined; physiological action uninvestigated:

Æsculus glabra Willd. Buckeye, bark.
Aralia hispida Vent. Dwarf alder, root.
Betonica officinalis Linn. Wood betony, herb.
Crataegus Oxycantha Linn. Hawthorn, "berries."
Gentiana ochroleuca Frœl. Sampson snakeroot, root.
Gentiana quinquefolia Linn. Five-flowered gentian, herb.
Impatiens aurera Muhl. and I. biflora, Welt., herb.

Ligustrum vulgare Linn. Privet, leaves.
Nymphaea advena Soland. Yellow pond lily, root.
Polemonium reptans Linn. Abscess root, root.
Polytrichum juniperinum Hedwig. Haircap moss, entire plant.
Rubus strigosus Michx. Raspberry, leaves.
Senecio aureus Linn. Life root, entire plant.
Sorghum saccharatum (Linn.) Persoon. Broom corn, seed.
Stylosanthes biflora (Linn.) B. S. P. Stylosanthes, herb.
Verbena hastata Linn. Vervain, herb.

Some Scientific Aspects of Tea Drinking.

Frank B. Wade.

An ancient beverage, and one now in more universal use than any other, not even excepting beer, tea has many claims as a wholesome and harmless adjunct to our meals.

Our English cousins, headed by that greatest tea merchant and good sportsman, Sir Thomas Lipton, seem to have come to a better appreciation of "the cup that cheers but not inebriates" than we in America have arrived at. You remember that, in Pickwick Papers, Sam Weller tells us that they drank tea until they "swelled wisibly." Our English friends at one time would even have compelled us to take to their favorite beverage had not a party of well-meaning, but rather hasty, Yankees dumped the first consignment of raw material into Boston harbor. Since then we seem to have retained a rather illogical prejudice against an excellent beverage.

Among its many virtues, not the least is that it supplies, in a harmless form, an adequate amount of water to the system. Physicians are agreed that most of us habitually take too little liquid. Many functional disturbances arising from this lack of water might be removed by acquiring the habit of tea drinking. Another advantage to be derived from the use of tea is in thereby obtaining water which is free from pathogenic bacteria and which is partly softened by boiling. The sterilization of the water and the removal of its "temporary hardness" are unmistakably advantageous in places where there is any suspicion as to the purity of the drinking water or where it is excessively hard.

To persons of sedentary life, with digestive powers not of the strongest, the simple physical advantage of the heat-content of the cup of tea is probably of material aid in facilitating natural digestion. It also acts as a mild stimulant, on account of the presence of the alkaloid theine. Any reasonable use of tea is unlikely to cause serious reaction from this stimulant, and the benefits upon digestion, of the cheerful state of mind produced by it probably more than compensate for any drain produced by it upon the nervous system. In case of personal idiosyncrasy toward tea it should, of course, not be used.

The chief objection to the use of tea seems to me to arise not from the theine content of the infusion, but from its tannic acid content when not rightly prepared. As ordinarily prepared by estimable old ladies the infusion of tea contains small amounts of more or less volatile oil, a small per cent. of theine, some coloring matter, and loads of tannic acid. Last year my landlady happened to be both estimable and orthodox and prepared my tea in the regulation fashion. In order to convince her of the error of her ways I carried over a test tube of lead acetate solution and, calling her attention to my cup of tea, I precipitated a heavy mass of bulky lead tannate in my cup, much to her surprise. On being informed that the result was due to the presence of tannic acid in the tea she exclaimed, "Why! I didn't think my grocer would do such a thing!" I think she never quite forgave that grocer even although I explained to her that the tannic acid grew in the tea plant and that she herself extracted it by long steeping. I had to get a tea ball and make my own infusion at the table to get well-made tea. It is true they called me "Miss" Wade after that, but I knew that the orthodox tea was fit only to tan hides, and I had too much respect for my interior to continue its use.

A short time ago a friend and I visited a celebrated local Chinese tea shop in order to test the quality of the tea. While the genial proprietor, Mr. Moy Kee, slumbered peacefully in his reclining chair my friend and I spied out the land in the rear of the curtain partition. Upon a lighted gas stove a blue granite ware tea kettle was boiling merrily. The proper amount of tea was put in a vessel, the boiling water poured over it and almost immediately poured off into the china teapot in which it was served to us. I do not, myself, particularly like the flavor of Chinese teas, but this tea was well made and very free from astringency. We noticed upon the menu cards two interesting names of teas—"Before the Rain," and "After the Rain." I was at a loss to understand the derivation of these names until next day at dinner, when, in discussing her method of making tea with my new landlady she told me that her method was just like Moy Kee's and that she found it very economical, as you could get an excellent second cup of tea from the grounds by re-extracting them. I knew then that my first cup of tea had been "Before the Rain" and my second cup "After the Rain."

In order to show strikingly the difference in the tannic acid content between tea prepared after the Chinese fashion of quick extraction by

boiling water and tea prepared by long steeping I secured ten samples of tea in the open market and extracted 4 grams of each in ½ liter of water by both methods. (See table and photographs.) In the quick extraction process the half liter of boiling water was poured over the 4 grams of tea, allowed to remain 1 minute and then the infusion was quickly strained into a clean flask. In the slow steeping process the half liter of boiling water was poured over the 4 grams of tea and kept at boiling temperature for about 5 minutes, then strained into a clean flask. To each of the twenty infusions excess of lead acetate solution containing a few drops of acetic acid was added. In the ten flasks containing quickly extracted tea scarcely any precipitate was found, while in the ten flasks containing the same kinds of tea extracted by the longer method very voluminous preciptates formed without exception. In other words the tea made by the orthodox method of long steeping contained vastly greater amounts of astringent material of the nature of tannic acid than the other.

Many people habitually drink tea of this description and, having become accustomed to it, do not like tea unless it is "strong enough to float a flat iron." That they enjoy a fair measure of health is only another tribute to the enormous resistive powers of the cells of the stomach lining. That many people are unable to drink tea of this type, and so do not drink any, is, I believe, due to its tannic acid content, not to its content of theine.

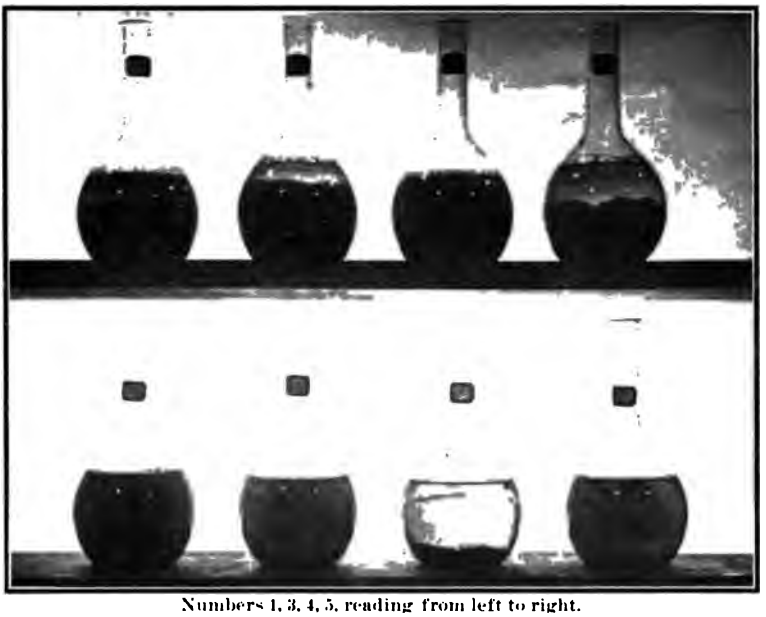
While most teas contain a slightly larger per cent. of theine than coffee does of its alkaloid (caffeine), yet, when we consider the weight per cup of dry material employed in making the two beverages, we see at once that the alkaloid content of the cup of tea is really considerably smaller than that of the cup of coffee. A teaspoonful of tea is liberal for one cup. The ordinary amount of coffee per cup is a tablespoonful. The coffee is denser than the tea, so the relative weights of coffee and tea per cup are about in the proportion of 5 for the coffee to 1 for the tea. Three per cent. is a fair average for the theine in tea and 1 per cent. for the caffeine in coffee, so the amount of alkaloid in the cup of coffee is really greater than in the cup of tea, even if all the alkaloid is extracted in each case. In reality the theine is not as completely extracted by a one-minute exposure to boiling water as the caffeine is by the longer extraction which coffee always receives. So the well made cup of tea is in truth only a delicately flavored and colored cup of hot water.

I think I may then conclude that tea, made by the method of quick extraction with boiling water, affords a wholesome source of fluid to the body while at the same time it gives, on account of its aromatic flavor and slightly stimulating properties, a pleasure to its users which makes it worthy of a far more extended use among us than it has yet reached.

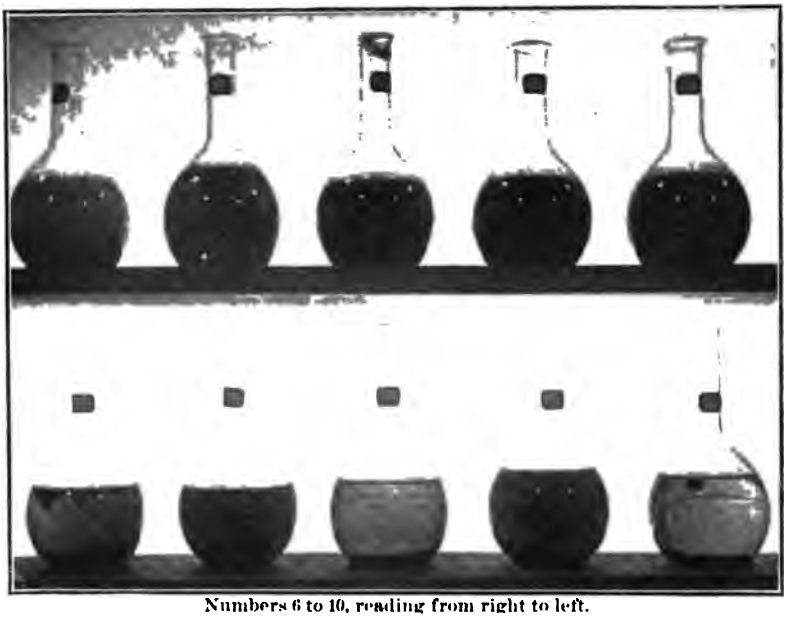
TABLE I.

No.	Name.	Price.	Taste.	Color.
1	Lipton No. 1	$0 60	Mild and pleasant	Black.
*2	No. 1, once used			
3	Imperial	60	Slightly aromatic, mild	Green.
4	Gunpowder	80	Very aromatic, strong	Green.
5	Needle Japan	80	Flat, astringent	Black.
6	Oolong	80	Slight aroma	Black.
7	Young Hyson	80	Aromatic, mild	Green.
8	Mixed tea		Aromatic, mild	Black and Green.
9	Formosa	90	Slightly aromatic, mild	Black.
10	Uncolored Japan	80	Aromatic, slightly astringent	Green.

*No. 2 flask broke. Not shown in photograph.



Numbers 1, 3, 4, 5, reading from left to right.
Upper row in each picture shows result of long boiling.



Numbers 6 to 10, reading from right to left.

The Radium Clock.

By R. R. Ramsey.

R. J. Stutt (Phil. Mag. 6, 588, 1903) has devised a very simple little device to show that a radium preparation takes on a positive charge due to the B-rays. This consists of a radium preparation enclosed in a thin walled glass tube. The tube is suspended in a vacuum tube by means of a quartz rod. To the lower end of the tube a gold leaf is suspended, forming an electroscope. The B-rays cause the tube to become positively charged, the L-rays being absorbed by the glass, the leaves diverge, and if the gold leaf is allowed to touch an earthed plate the charge is taken off and the process of charging begins over again with a regularity which suggests perpetual motion. The term radium clock has been suggested by some one as a name for the device. It was the original intention to exhibit one here today.

The only successful one which I have been able to make is the one I had when the title was sent in. Since the period of this one is about 48 hours, I have concluded your faith would be tried as much with the exhibit as without. However, the tube is on the table. It was my hope to be able to make one in a neat, short tube with a quick period which could be used in front of a lantern. To accomplish this 50 mg. of 10,000 activity radium was placed in the tube. The quartz was discarded and the tube set upon a block of hard rubber in the bottom of a test tube, with the gold leaf hanging alongside of the radium tube. When exhibited to a vacuum of lower pressure than my first tube, the gold leaf refused to move. The tube was prepared again with a quartz rod between the tube and the hard rubber. This also failed to work. Since the gold foil hung alongside the radium the B-rays were partially absorbed by the gold, thus neutralized the charge. At the last moment I was forced to come back to the original form. This has failed to work, probably due to dirt on the quartz rod. The essentials for success are plenty of high activity radium, thin glass, containing tube hermetically sealed, perfect insulation and a good mercury pump.

The Use of Peat as Fuel.

By Benjamin W. Douglass.

Peat is that product of vegetable decay which we find composing the soil of most of the swamps of temperate zones. We may expect to find it any place where bog conditions exist. Europe, Asia and America contain extensive bogs and it is estimated that the total area covered by peat is many times greater than the total area of all known coal fields.

The peat bogs which occupy over 15 per cent. of the area of Ireland have for centuries been the main source of fuel in that island. In fact the term "peat" has become so intimately connected with Ireland that popular fancy has imagined it to be characteristically and exclusively an Irish product. As a matter of fact, a most incomplete survey indicates that the peat fields of America exceed not only those of Ireland, but are larger by nearly a hundred times than the combined bogs of all Europe. Thousands of square miles of peat of the finest quality exist throughout the Northern States and Canada. New England has whole counties of it. The Great Dismal Swamp of Virginia is one continuous peat bed. New York, Ohio, Indiana, Illinois, and the Great Northwest contain deposits of peat, the value of which is as yet almost unsuspected. In the bogs where it occurs it is a closely matted, felt-like substance, very fibrous and usually very wet.

Just as coal and wood exist in many varieties, we find similar variations in peat. In general all peat may be classed under one of two varieties: The black peats, which are composed of the bodies of grasses, sedges, and other large plants, and the brown peats, formed from sphagnum and other mosses. It is the latter variety which forms the immense beds of North America, and for the purposes of this paper it will be understood that we refer only to this brown form.

In its pure state peat contains only such inorganic matter as was present in the bodies of the plants from which it was formed. Impure peat may contain other inorganic matter, as sand, clay, silt which has been washed in from adjacent hills, or deposited by the overflow of streams, as the location of the swamp would indicate.

The use of peat as a fuel by no means limits its range of useful application; ardent experimenters have found many ways of utilizing this humble stuff.

Where thorough drainage is possible, peat lands have proven excellent for agricultural purposes, though in most cases requiring the addition of considerable quantities of potash. As a fertilizer peat has been demonstrated to possess decided value and is so used extensively today. From the more fibrous peats an excellent paper is prepared, large works in Germany being devoted to its manufacture. As a disinfectant

A typical Peat bog.

and deodorizer, powdered peat has been sold, under an assumed name, for some years, and most excellent results have been obtained from it. Indeed the range of possible use of this remarkable substance seems almost limitless. It has been used as a substitute for charcoal in the manufacture of fireworks, coarse heavy cloth has been prepared from it, a recent patent claims its successful use as a substitute for papier-mache, a serviceable cement has been made from its ashes, and within the past year the agriculturists at an Indiana college have suggested the possible value of peat as a stock food.

While the work of demonstrating these possibilities was necessarily very great it has not been so extensive as the experiments which have been made along the line of developing its use as a fuel.

Crude peat, cut from the bogs with spades and piled in the open to dry, has fed the fires of peasantry in Europe for centuries. Extremely light and spongy in character, burning slowly, with only a moderate amount of heat and considerable smoke, it made a very poor fuel

The crude process of Peat mining as practiced in many European countries.

indeed. Its great bulk, its friable character and the readiness with which it absorbed water, made the problem of transporting it almost insurmountable, even had there been a market for so crude a fuel.

As the European forests were destroyed or protected from further destruction by the governments, wood as a fuel became scarce and the price of coal arose accordingly.

As early as 1821 we find that German inventors had directed their attention to the problem of compressing peat. It no doubt seemed a simple problem to those first experimenters, as it has to most of the investigators of more recent times, but it was nearly three-quarters of a

Block of Peat from the surface of a bog, showing the Sphagnum Moss.
(Natural size.)

century before any practical process of briquetting peat was devised. Early inventors, not unlike some later ones, thought that peat could be condensed and dried by simple pressure. Hundreds of thousands of dollars were spent in demonstrating the fallacy of this theory, a fallacy that is self-evident when once the character of the material is fairly understood.

As it comes from the bog, peat contains from 75 to 80 per cent. water. The fibrous character of the substance prevents the removal of this water by direct pressure and also accounts for the difficulty experienced in drying the crude material by exposure to the air. Not only is the moisture held between the fibres of the peat but it is contained in the capillary spaces running through the fibres, and any successful process of fuel making must contemplate the destruction of the fibrous nature of the material.

At present, investigators are working on two general processes for the conversion of peat into a marketable fuel. The older of these methods may be called the wet process and consists in breaking and grinding the wet peat until it loses its fibrous structure and becomes almost like clay in its plasticity. It is then moulded into blocks of convenient size and allowed to dry spontaneously. In drying, the briquettes shrink to about one-third their original size and become very dense and hard, and when thoroughly dry contain only from 5 to 10 per cent. moisture. Crude peat, that is, peat as it comes from the bog, can not be dried below about 20 per cent. moisture, owing to its fibrous nature.

Peat prepared in this general manner has long been a commercial article in many European countries. Germany, Holland and Russia use large quantities of it, and I am told that more than two million tons are marketed yearly in Sweden.

Considering the progress which this industry has made in Europe it is surprising that America is only beginning to utilize the vast stores of this fuel with which she is so richly supplied.

In the natural transformation of peat into coal (for coal is but an advanced condition of marsh mud) three fundamental changes take place: the peat is dried, compressed and carbonized. It was an attempt to imitate this natural process which led to the discovery of another way of making peat briquettes. In this "dry process," as it is called, the peat is first artificially dried and pulverized in machines constructed for that purpose. This dry peat powder is then compressed under heavy pressure into a hard and dense briquette. While this process produces a briquette of excellent quality, no compressor has as yet been patented which is a commercial success. The past few years have seen many dry peat-pressing machines offered on the market, all of which have failed either from actual inability to do the work or from too great cost of operation.

Compared with coal, briquettes made by either of the above processes have many advantages to offer. Calorimetric tests show that condensed peat possesses a fuel value equal to the best coal, and practice proves that this fuel is available under ordinary conditions of burning. The best of coal contains slate, shale, iron and other clinker-producing elements. Clinkers inhibit the supply of oxygen (air) and the carbon, unable to burn, goes up the chimney in the form of smoke. On the other hand, the very nature of its origin prevents the possibilty of clinker formation in a peat fire. The ashes of the new fuel, fine and soft as cigar ashes, fall through the grate bars and allow a constant supply of fresh air to pass through the fire, thus securing perfect combustion and practically no smoke.

It has been urged against peat that it contained a high percentage of ash-producing constituents. A marketable peat will contain from two to ten per cent. of ash, pure coal from two to eight per cent. These are the figures of the laboratory. As a matter of fact the average per cent. of ash from a coal fire is from 20 to 35 per cent. and in it is contained not only ashes and clinkers but also quantities of unburned coal—the result of choked grate bars.

The almost universal absence of sulphur in peat renders it a far more wholesome fuel than any of the soft coals. Indeed so mild is the smoke produced from peat that it has been used in emergencies as a substitute for tobacco.

In specific gravity, this condensed fuel will vary from about 1.10 to 1.65. In other words a ton of it will occupy about the same space as a ton of hard coal.

While peat briquettes are not absolutely waterproof, they are relatively so, for when once the fibre of the material is destroyed and it has been allowed to dry, no amount of soaking will reduce it to its original condition.

Recently some attempt has been made to combine peat with various other substances. For one reason or another all of these mixed fuels have failed. One of the most notable of these combinations uses a certain proportion of crude petroleum. As a result a pile of such fuel is constantly liable to spontaneous combustion.

Mixtures of peat and anthracite dust have failed, owing to the necessity of using an expensive "binder" to give the briquettes solidity. Aside

from their high cost, binders in fuel of this type have failed for two reasons. The organic binders (as starch) burn more rapidly than the fuel proper, and as a result much unburned matter falls through the grate bars. On the other hand inorganic binders add so materially to the resulting ash as to render their use impractical.

The most successful process of briquetting peat will be found to be the one which is the least complicated, for simplicity will tend not only to economical production but to practical operation as well.

In conclusion it is not too much to predict that the peat fuel industry in America will rival in magnitude the coal industry of today. It is difficult to conceive of the importance which this industry must have in the development of our great Northwest, but it is there, in a region destitute of coal, though rich in every other respect, that we must expect to find the first and most extensive use of peat fuel.

The Chronic Ill Health of Darwin, Huxley, Spencer, and George Eliot.

By Robert Hessler.

(Abstract.)

This paper was an inquiry into the chronic ill health of the individuals mentioned in the title, based on a study of their life and letters, and was illustrated by charts and diagrams. The paper was in line with former ones read before the Academy, and showed how the influence of city dust cropped out in the biographies of men and women.

The ability to live in a dusty city atmosphere differs greatly. Some individuals are scarcely influenced by city dust, others are very susceptible and complain or suffer constantly. The list of disease and symptom names used, especially by Huxley, is suggestive of dust infection—the symptoms subsiding on going away from the city and out into a good atmosphere. The symptom names were shown in groups and their significance pointed out. In a general way, living in a good atmosphere meant health, while living in a polluted one meant ill health. Seeming exceptions should be studied in the light of the experience of living individuals, susceptible to the same influences. In a city the season of the year and the direction and force of the wind have to be considered as factors. The evil influence of the East Wind is frequently referred to; an east wind means the blowing over of the dust and smoke from the heart of the city. City dust may be brought to a country resident, as in a lot of books from a city library; and where the books are read while in a reclining position the evil influence of the dust may be quite marked. A visit to a hall or room crowded with a mass of humanity may be followed by an attack of ill health. Where the symptoms are more or less continuous, nervous manifestations may predominate.

As a rule biographies dwell only lightly on the subject of health and disease and references may be quite vague; the Life and Letters of Huxley are an exception, and are worthy of a close study, especially by those who are influenced by city dust.

The Wood Pulp Industry.

By M. D. Renkenberger.

Wood pulp and the wood pulp industry have come to their present importance within the last twenty-five years. An increased use of paper, of which wood pulp forms a large per cent., appears not only in newspapers and all kinds of common papers but in the manufacture of many useful and ornamental articles. This increased use of wood pulp in the paper industry, together with the fact that the particular kinds of timber used for pulp exist in limited amounts, makes it not only wise but absolutely imperative that the matter of raising trees for pulp wood be considered. Unless, indeed, some substitute is found for wood pulp, this matter must be taken up seriously in the States, and that within a very few years.

The wood pulp industry first appeared as such in the census of 1870. Since then the growth has been rapid and steady, the increase in the value of raw material, for example, in 1900 being more than 59 per cent. over the value of material consumed in 1890. The growth of our export trade in paper and pulp stock has been steady and healthful, amounting in 1900 to a total of $6,674,296, an increase of nearly 500 per cent. during the decade. The grades exported are largely wood papers (especially news), while the usual imports are of the higher grades of book and fancy papers and specialties. The per capita production of paper has increased from 8.1 pounds in 1860 to 56.9 pounds in 1900, the per capita value of which is now over $1.66. One author claims that more wood is consumed in the form of pulp by the great paper making establishments than is used by the combined railway systems of our country.

The raw material for pulp comes chiefly from the spruce and poplar of northern United States and Canada. At the enormous rate at which this one industry is using up existing timber, to say nothing of the vast drain made upon the virgin forests for lumber, fuel, etc., there will soon come a time when either inferior grades will have to be used or a substitute be found. As yet few attempts have been made to raise trees for pulp wood and as the consumption of wood for this purpose is enormous,

and as the virgin supply is limited, the writer sees no reason, in view of the steadily raising price of pulp wood, why the growing of trees for pulp can not be made a profitable business in forest culture.

Historical.

From the earliest Egyptian papyrus to the paper of today the predominant characteristic is that it consists of the enduring portion of vegetable growth known as cellulose or pure fiber. All parts of plants have been used for this purpose and a list of raw material used for paper would include linen and cotton rags, jute, hemp, esparto grass, wood pulp, clay, straw, peat, cornstalks, and a half dozen others.

The discovery that wood could be converted into its component fibers and freed from lignin, gums, etc., became the basis of modern paper making and brought the wood pulp industry into prominence in a largely forested country. The German process for making "ground wood" was introduced into this country about the middle of the nineteenth century, the soda process from England a century earlier, and the sulphite process is an American invention of about 1867, and owing to its cheapness in producing a strong cellulose fibre from spruce, its use has increased more rapidly than that of the soda process. The first wood pulp made in this country sold at 8 cents per pound; today the price of "ground wood" pulp is about 1 cent per pound. The scarcity of rags and the cheapness and abundance of the pulp supply in the great forests of spruce and other woods caused the new material to be generally adopted. At first aspen and basswood were preferred for paper making, but as the supply of these woods was quite insufficient for the demand, coniferous wood was tried, and spruce soon came into the first rank for the purpose. This widespread demand, which has steadily increased, has been one of the chief causes of the destruction of large areas of forests—forests, too, in which no steps were taken toward reproduction either natural or artificial. In North America during the three years ending in 1894, 200,000 acres of forests had been denuded to satisfy the demands of 210 paper factories.

Uses of Wood-Pulp.

The principal use to which wood pulp has been put is in the manufacture of the coarser kinds of printing, writing, and wrapping papers. The use of the German process for making a ground wood fiber has steadily increased, to a great extent superseding the use of rags, entirely

so in the manufacture of news and wall papers, very largely so in the manufacture of book and wrapping papers and to a considerable proportion in writing and other grades. In fact fifty per cent. of our paper is manufactured from wood pulp.

Wood pulp is used for many other purposes besides paper making, sometimes usefully, at other times with doubtful advantage. Such are: the use of compressed pulp bricks for construction purposes; its use in textiles such as silk and cotton; in panelings and interior house decorations; in celluloid, surgical bandages, car wheels, pulleys, paper boxes, pails, barrels, etc.; for filters in breweries and sugar factories; for fuel, etc. As compared with paper making, however, these other uses of wood pulp are only of subordinate importance and perhaps hardly consume one per cent. of all the wood pulp thrown onto the market.

Raw Material and Preparation.

The raw material of wood pulp is spruce, poplar, and in smaller quantities various other woods such as balsam, hemlock, birch, according to the location of the industry, the process employed, and the kind of paper in which the material is to be used. The variety as to the kinds of trees that have been used with varying success at various times and places is extensive; such are soft pine (hard pine containing too much resin), fir, spruce, balsam, hemlock, birch, large-toothed aspen, cottonwood, Carolina poplar, buckeye, basswood, box elder, quaking asp, beech, bamboo, linn, willow, soft maple, catalpa and perhaps others—in fact any tree can be used, it is merely a question of relative value and relative expense. The kinds of timber most largely used in pulp manufacture are soft, easily worked, light both in weight and color, possessed of long fibers, not fading easily, and containing little resin or other infiltrations. It will be seen that spruce among conifers and poplar among broad-leaved trees possess the requisite qualities in a remarkable degree. In the United States spruce forms 76 per cent. of all wood for both mechanical pulp and chemical fiber. Poplar being softer (and used most for soda fiber) forms 12.9 per cent. of all woods consumed in making different kinds of pulp. Other unspecified woods for pulp or fiber make up the remaining 11.1 per cent.

In the preparation of pulp, the wood should be worked up green and the bark and defective parts must first be taken off. There are two principal methods of reducing wood to pulp—the mechanical and the

chemical. These two methods give different results as regards paper manufacture, the product of the mechanical method, termed "paper pulp" being more granular, whilst that of the chemical method, termed "cellulose," is more fibrous, and hence stronger. In making the mechanical pulp, the wood is cut into suitable lengths for grinding, the bark removed, and the blocks held by hydraulic pressure against the edge of a rapidly revolving sandstone and by attrition reduced to a mushy consistency. The fiber as thus ground is passed through filterers of various fineness. The fibrous mass is now brought to another machine, where the water is pressed out, and it is cut into slabs, baled, and shipped to regular paper mills without drying. The pulp so made is the basis of all lower grades of paper. As already noted, the pulp industry has become an integral part of the paper business, over half of the ground wood produced being made into paper on the spot.

By the chemical process, which is more recent and more costly, but which produces a much longer fiber, the finely ground wood fragments are placed in large boiling tanks or digestors, lined inside with lead or other acid-resisting material. Chemical pulp or "cellulose" is of two kinds, depending upon the use of caustic soda (alkali) or calcium sulphite (acid) to macerate the wood. It should be remembered that all chemical processes of wood pulp manufacture are based upon the underlying principle that the middle lamella and infiltrated material which surrounds and holds together the individual fibers of wood is soluble and produces a chemical reaction with certain aqueous solutions, notably that of the bisulphite of lime. The problem is to apply the macerating liquid under conditions which will completely and quickly eliminate the infiltrated substances without unnecessarily weakening the fiber, and for this purpose the solution must be applied at a high but carefully governed temperature and under a mechanical pressure that will force the chemical solution into every pore of the woody structure, thus permitting it to attack the non-cellulose matter in which the fiber is embedded and by which it is permeated. The matrix thus loosened and dissolved is removed by washing with water.

Where sulphite of lime is used, the wood fragments are boiled in sulphurous acid from 24 to 60 hours under a pressure of about three atmospheres. The soft, crumbling, reddish-yellow pieces are then pounded, washed, filtered, and pressed into sheets about the thickness of pasteboard.

When soda is used, the woods employed are usually softer, of mellower fiber, and without much strength. The process is similar to that of sulphite, except that in place of sulphurous acid a solution of caustic soda is used in the digestors. There are various other methods by which attempts have been made to separate the wood fibers, most interesting of which perhaps is Kellner's electrical process, in which the wood, boiling in a solution, commonly salt, is subjected to electrical discharges. The value of this process has not been ascertained, however. Of all the chemical methods in use the sulphite method is by far the cheapest and most satisfactory.

Characteristics and Advantages of Wood-Fibered Paper.

Ground wood with an admixture of from 10-25 per cent. of the chemical fiber is used for newspaper stock, wrapping paper, and for many of the lower grades of book, magazine and writing papers. For the very best grades of paper, whether for printing or writing, an admixture of sulphite with rag pulp is necessary. For permanent records the author is of the opinion that only rag pulp, and that of the best quality, should be used. It is true that in from 15 to 20 years the "wood pulp" books, papers, etc., will be greatly deteriorated and that for permanence some other substance must be used. A writer in a recent number of the "Outlook" suggests that publishing houses should print a special edition of each publication on a special quality of durable paper, suitably resistant both to chemical and mechanical wear and tear and thus preserve them for posterity. Whether or not the people of our country are careless in this matter, the fact remains that papers made from wood pulp and especially mechanical fiber, are perishable, and that within a very short time. Notwithstanding the great desirability for permanent copies of all our good publications, the larger majority of printed matter will continue to be discarded after the first reading—newspapers entirely so and magazines and even books to a large degree at least at the end of six months or a year. It is quite probable that the same prodigality would exist if our papers were made of the scarcer rag pulp, but wood pulp is not only cheaper than pulp made from rags, but it takes impressions better, wears out type less and decreases the possibility of spreading contagious diseases.

Future Needs and Possibilities of the Wood-Pulp Industry.

Having given a more or less incomplete account of the production, uses, supply, and present status of wood pulp let us now notice what this enormous industry means to our limited forested areas. Some idea of the rapid destruction of our spruce forests for pulp purposes can be got from the following: "A prominent New York newspaper uses 150 tons of paper daily. To produce this amount of paper 225 cords of spruce wood are consumed. It requires 1½ cords of wood to produce one ton of paper pulp. As the spruce ordinarily occurs in our northern mountains it averages about 5 cords to the acre." This means that every day, for this one newspaper alone, 45 acres of our mountain spruce are being consumed. Of course in the best spruce stands, such as those of Saxony and Bavaria, where large quantities of spruce are raised for pulp, it grows in dense, pure stands and yields many times as much as the average acre in this country, at the lowest about 20 cords. Even at that a single edition of a metropolitan Sunday paper would use up more than 10 acres of the very best spruce stand.

And again, from the Scientific American of November 14, 1903: "It has been estimated that nine novels had a total sale of 1,000,000 copies. This means 2,000,000 pounds of paper. The average spruce tree yields a little less than half a cord of wood, which is equivalent to 500 pounds of paper. In other words, these nine novels swept away 4,000 trees. Is it any wonder that those interested in forestry look with anxiety upon the paper mill?"

Paradoxical as it may seem however, in those countries that are growing pulp timbers, the paper pulp manufacturer is the most powerful ally of the forester in that he uses the thinnings of the forest which begin while the forest is still young and continue throughout its whole existence.

The situation of the pulp manufacturer is well given by one of our most active foresters, John Gifford, who says: "The pulp manufacturer's plant represents the investment of perhaps a million dollars, while the plant of the lumberman is worth only about ten or twenty thousand dollars. The lumberman owns the land not for the land's sake, nor for the amount and quality of timber the land is capable of producing, but for the crop which covers it. He buys it, uses it, and then abandons it. He pays taxes on it only during the process of reduction. The pulp

man on the other hand, is tied to the soil. His heavy investment makes him fearful as to future supplies. For this reason, with commendable foresight, some of the pulp men are buying the land with the timber, and are beginning to work the woods in such a way that future supplies may be assured." It is foolish to suppose that our natural forests under present management and weak attempts at planting will furnish a supply of pulp wood for the future use of the people. Extensive correspondence with paper pulp manufacturers in several States, including Minnesota, Wisconsin, Michigan, New York, Ontario, Pennsylvania, and Indiana, reveals the fact that all agree that the supply of our best pulp timber must shortly give out, but few consider the matter seriously enough to suggest any definite plans or directions for the present. At this date, however, the author is informed that the United States Forest Service has begun the investigation of the wood pulp industry, but have not yet proceeded sufficiently far to warrant a report on the subject. Our own State, too, according to the statement of the secretary of the State Forestry Board, intends to demonstrate on the Forest Reservation in Clark County that growing timber for pulp industries would be a profitable thing on the cheap lands of the State. Indeed, land fitted for agricultural purposes could not profitably be used for any branch of forest culture. Such waste lands as could be profitably utilized in growing pulp wood exist in thousands of acres all over our country. There are the numerous burnt-over slash lands of our pine States; the arid wastes of many of our Southwestern States; the unused agricultural lands of the New England States, and the innumerable other tracts of unused, low-lying, light-soiled areas throughout the valleys of the Missouri, Ohio and Mississippi rivers. As nurse trees, in shelter belts, sand fixers, windbreaks, etc., trees which make good pulp might also be grown.

In view of the facts: (1) that the demand for pulp timber has increased wonderfully in the last few years, (2) that the price of raw material, according to a well known authority, has increased 150 per cent. within the last seven years, (3) that the native supply is limited and can not last many years, (4) that the importable supply is inadequate in those countries from which we could ship it profitably, and in countries such as Canada, blessed with a great abundance of pulp timber, the prohibitive tariff is so high (over $4.00 per cord) that we can not possibly afford to have it brought in, (5) there is only a small probability that an abundant and successful substitute can be found for the use of wood pulp in papers;

—in view of the above facts and of the abundance of unused land in our country, the author is encouraged to believe that the time will soon come when the growing of pulp timbers will be one of our recognized industries, and therefore has some hope of results from the application of the following suggestions.

Suggestions, Recommendations, Estimates, Etc.

Of the trees used for paper pulp, spruce, hemlock, and poplar are the most widely used and collectively furnish perhaps 90 per cent. of all wood used either for ground wood or chemical fiber. Spruce is used mostly for "ground wood" and sulphite pulp, forming as ground wood almost the entire substance in newspapers, and as sulphite fiber from 10 to 25 per cent. of the stock in the better grades of printing and writing papers. Spruce now brings from $9 to $11 per cord, and as it is rapidly becoming a substitute for pine, its value will rise. It is recommended that spruce be planted either in pure stands or mixed with poplar or hemlock on the numerous burnt-over, non-agricultural lands in our north-central States. According to a paper manufacturer of competent authority, the virgin spruce forests of northern New York which were cut over from 20 to 30 years ago are now affording spruce trees from 12 to 20 inches in diameter and are being used for paper pulp with good results.

Hemlock, and especially the western hemlock, makes a good sulphite pulp, and, as the spruce supply fails, is steadily taking its place not only as a lumber substitute, but, on account of its high cellulose content, in the wood pulp industry also. References to figures and statements in well known publications will substantiate the statement that the growing of spruce and hemlock for pulp wood on the available tracts would be a profitable industry.

In this country the poplars furnish 12.9 per cent. of all woods used for pulp of all kinds, being chiefly used for soda fiber mixed with from 10-20 per cent. of stronger pulp. Poplar pulp forms the chief material for such papers as the Ladies' Home Journal and Youth's Companion. Sulphite pulp alone would make too harsh a paper, while soda pulp alone would make too weak a paper. Mixed together in the proper proportions, however, a paper characterized first by strength, second by softness and delicacy is produced. The use of poplar for pulp is rapidly spreading in the east-central States, great quantities being shipped in from the Carolinas and adjoining States. A forester of one State has recently said:

"If I could replace the maples in the State forest by poplars today I would do it gladly. It would be worth thousands of dollars to the State." Considering the rapid growth and ease of propagation of the Populus family, there seems ample excuse for estimating its probable success on the cheap lands of our own State. In fact the author feels confident that such trees as aspen, cottonwood, and its subvariety, Carolina poplar, can not only be grown at a reasonable profit, but will make productive the capital locked up in our low-priced, non-agricultural lands. The practicability of planting depends upon the possibility of protecting the land and the return to be expected. The question of protection from insects, stock, fire, etc., must be answered with respect to the individual case. For the land which can be protected there remain to be considered the cost of planting, the rate of growth, and the probable returns.

Estimates of Cost and Returns per Acre for Cottonwood.

The estimate following is intended to cover the cost and returns for one acre of planted cottonwood on the cheap unused lands of Indiana. Other members of the Populus family, such as aspen, may be planted on waste areas with practically the same cost and yield. As cottonwood does not form sufficient shade to keep out weeds and grasses, the Federal Forest Service advises that the understory should consist of box elder, hackberry, white elm, osage orange, or such shrubs as wild plum, choke cherry, wild currants and gooseberries.

The cottonwood seedlings, preferably yearlings, or better, cuttings, can be obtained cheaply from nurserymen or may be collected by the planter from the sandbars along streams. The seedlings or cuttings should be planted where they are to remain permanently. Planting is a very simple operation. It may be advantageously performed by a man and a boy working together. The man, by driving a spade into the ground, makes a slit, into which the boy slips a tree behind the spade; the man then withdraws the spade, trampling the soil about the tree as he advances to plant the next one.

Cottonwood plantations should be protected for at least five years from grazing animals, and five or six plowed furrows free from weeds should be maintained around the grove to keep out fire. If the undergrowth recommended by the Forestry Service is not planted, cultivation for two or three years will be necessary.

For the sake of definiteness, it is assumed that at the end of 20 years the stand will be sold on the stump for pulp wood. Indiana waste land suitable for such purposes is classed as worth perhaps $12 per acre, although the author is informed that many tracts in Greene, Monroe, Brown, Lawrence, Owen and southern Putnam and Park counties can be bought for less than $12 per acre. For purposes of taxation, the forestry law of 1899 appraises such land at $1 per acre, making the taxes practically nil. It will require 680 seedlings to plant the acre at a distance of 8 by 8 feet. The cost of these is estimated at $2. After the land is cleared, at the end of 20 years, the value doubtless will be as great as at the beginning, but the value of the land is not taken into consideration. Should $12 be added to the $120 which it is estimated could be secured for the timber product, it would simply increase by that amount the profits of the transaction. The statement following shows the items and amount of the investment for one acre:

Expenses on 1 acre for 20 years—

Cost of seedlings	$2 04
Cost of transplanting at $4.50 per 1,000	3 06
Value of land	12 00
Taxes at $1.80 per $100	36
Cultivation for 2 years	2 40*
Total	$19 86

Amount at 3 per cent. compound interest, $35.87.

At the age of 20 years the average cottonwood is 14 inches in diameter with a height of 50 feet. Studies made by the Forestry Bureau on cottonwood as a planted forest have shown that the yield in average cases has been at least 30 cords per acre in 20 years. Other practical foresters would harvest the crop in 10 or 12 years, thus securing less cords per acre, but owing to the shorter period of investment a higher annual per cent. on money invested. Under the 20-year plan, the 30 cords would sell on the stump at not less than $4 per cord, bringing $120. Deducting from this sum the amount at 3 per cent. compound interest, $35.87, there remains $84.13 as a return on the investment over and above that received from a 3 per cent. compound interest loan. This is equivalent to a return of $4.20 per year from the time of planting to the time

* This expense may be eliminated if cover is planted as recommended above.

of cutting, a very satisfactory return considering the fact that it is secured from land which is practically useless for any other purpose, and which without a timber crop would be a source of constant expense for taxes. The pulp wood crop not only gives a fair margin over and above ordinary investments but it makes productive the capital locked up in the land.

In this estimate the cost is the record of actual facts; the assessed valuation, such as could be obtained under the present forestry law of Indiana; the rate of interest, the average per cent. that money returns to its owner above taxes; the rate of growth, the average of planted cottonwood in the Mississippi Valley and the price less than that which has already been received where fair access was had to market.

Since the estimate is based upon present conditions, it more nearly applies to a plantation established 20 years ago, and to be marketed now, than to one established now and to be marketed 20 years in the future. Wood prices, according to B. E. Fernow in the Forestry Quarterly, vol. III, No. 1, have steadily risen and are now rising much faster than in the period before 1890. This same authority says further that the rate of increase in wood prices in general will be at least at the rate of 2 to 3 per cent. per annum for the next 20 years. This means that the return on the investment would be proportionately greater.

Besides the financial advantages from raising pulp trees, the general advantageous influences incident to forested areas would be more largely secured and our State would be more diligently doing her share towards the proper reforestation of areas which should naturally be in forest. The progress is encouraging, investigations are being made and many others are being planned. Both pulp men and foresters are taking an increased interest in the matter, and in many other ways the indications are that the industry of growing pulp wood will eventually occupy a prominent place among the profitable employments in the States and Provinces bordering our Great Lakes.

At this point the author wishes to express his indebtedness to the botanical department of Wabash College for substantial aid in collecting statistics and in numerous other ways materially assisting in the preparation of this report.

Crawfordsville, Dec. 1, 1905.

Notes and Photographs of the Development of a Buzzard.

By D. W. Dennis and W. C. Petry.

Throughout southwestern Ohio and southeastern Indiana the turkey buzzard, Cathartes aura, is a common bird, but the nests are seldom found. Accordingly we were glad to learn in April, 1905, that during each of the preceding four summers a pair of these birds had nested only a few miles away. We expected that the nest would be again used, and on the 22d of April visited the place; we found that two eggs had been laid and that incubation was in progress. The bird on the nest hissed when approached, and would not leave the nest until forcibly disturbed; she then ran out and flew away, but soared about overhead until we went away, when she almost immediately returned to the nest.

This nesting site is about four miles east of New Paris, Ohio; it is near a small creek and in a very hilly country. It is at least a half mile from any house or highway, on the edge of a rather open woodland. The nest itself was in a hollow sycamore log (Fig. 1) nearly five feet in diameter at the butt; the cavity extends back about eight feet, where it has a diameter of about two feet, and there it terminates abruptly. This cavity contained a quantity of dirt and rotten wood, but nothing from which to make a nest had been carried in. A hollow had been scratched in the debris at the extreme end of the cavity and the eggs laid in it. They were rather conical in shape, a little larger than a hen's eggs, and were white, splotched with brown.

On May 17th both eggs hatched. The young birds were very helpless; they could not stand in an upright position for about three weeks. That part of the head and neck usually bare in buzzards and a line down the center of the throat and breast were bare. The bill was very large and its tip was sharply hooked. After the young were hatched the old birds were never seen about the nest, though they were frequently seen "oozing" around overhead.

We were unable to learn when the young were fed. On May 27th we went with a party of students to examine and photograph the birds and

nest. After photographing the nesting place (Fig. 1) the camera was placed in the end of the log and a flash light of the young birds in the nest was secured (Fig. 2). The birds were then removed from the nest, photographed at closer range a number of times (Fig. 3), and replaced in the nest. They offered no resistance whatever and seemed little if at all frightened.

On June 3d and June 9th other photographs (Figs. 4 and 5) were taken. The birds had by this time become larger and much more active than before; on the latter date when they were placed in the end of the log they at once hurried to the darkest corner. Also on this latter date they first attempted to defend themselves by vomiting up a portion of their food. It may be easily guessed that this is a very efficient means of defense.

On June 13th, when we next visited the nest, we found but one bird in it. The tenant of the farm afterward told us that several days before he had noticed that one of the birds was dead and had removed it from the nest. The remaining one was in no way injured and we were unable to learn what had killed the other. We removed and photographed the living one (Fig. 6). At this time, 32 days after hatching, the black primaries and tail feathers were beginning to appear but were not conspicuous enough to show in the photograph.

By July 1st the black primaries had become very noticeable, as shown by Fig. 7. When the bird had been pulled to the end of the log with a stick, it was usually seized by the tips of the wings and carried out to the front of the camera, which had previously been set up in a suitable place. When it had been set down it would always stretch its wings to their full extent before folding them. Figure 8, taken when the wings were thus extended, shows well the black feathers in the back, wings and tail.

Figs. 9 and 10, taken July 9th, and July 15th, respectively, show the gradual change from white to black. By the latter date the back had become almost entirely black, but the breast and belly were still pure white. The bill had become more slender and more sharply hooked. The bird would now strike vigorously with its bill at anything that disturbed it.

Fig. 11 was taken July 23d. This was 67 days after hatching; the wings and back were entirely black and there were many black feathers

on the breast and belly. The head was bare with the exception of short down on the back part. The bill was still of a dark color, though changing toward reddish.

On July 30th, when we returned, the bird was in the stump at the butt end of the log; it was easily caught and placed in a position favorable for photographing, when suddenly it sprang off the log and flew away; its flight was difficult and at no time more than 20 feet above the ground; after flying about 100 yards it alighted on a fence; we at once followed it with the camera, hoping to get close enough to get a good picture, but whenever we approached within about 50 feet it would again fly. We finally secured a picture (Fig. 12) at about 40 feet distance. At this time, 74 days after hatching, the bird was almost entirely black, and fully as large as an adult bird; a little of the white down still remained on the sides, about the neck and legs and on the under sides of the wings; from a distance one would have been unable to distinguish it from an adult.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

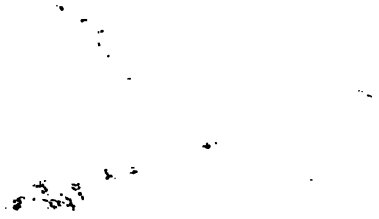
Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.



Observations of the Total Solar Eclipse of August 30th, 1905.

By John A. Miller, Indiana University.

Early in the year 1905 the Observatory of Madrid published detailed information regarding the eclipse that was to occur on August 30th of that year. Among other things this "Memoria" contained the results of a long series of observations of the prevailing meteorological conditions of many stations well distributed along the path of totality in Spain. The state of the sky in the immediate vicinity of the sun had been observed daily from 12:30 to 1:30 p. m. (the time at which the eclipse occurred) from the 15th of August till the 15th of September. The results of these observations, as well as the data gathered by the regularly established meteorological stations, touching the mean relative humidity, mean temperature, the velocity and direction of the prevailing winds, etc., had been tabulated. From these data it appeared that the probability of clear weather in the eastern half of the belt was exceptionally large, and indications for good eclipse weather were perhaps best in the regions near Ateca, Almazán and Daroca. The eastern half of the belt of totality in Spain held about 50 eclipse stations, established by astronomers from every nation of Europe, from the United States, and Mexico. The Lick Observatory expedition was located near Ateca; the United States Naval Observatory at Daroca. The observers from Kirkwood Observatory, Indiana University, Bloomington, Indiana, chose Almazán, Spain a small town northeast of Madrid in the Province of Soria. The approximate position of this station is longitude=13 m. 56 sec. W. of Greenwich, latitude=41° 10′.

The party consisted of Professor W. A. Cogshall, of Indiana University; Messrs E. C. Slipher, F. A. Crull, and C. J. Bulleit, students of the university; Professor A. F. Kuersteiner, Mrs. Miller, and myself. We were assisted in the manipulation of our instruments on the day of the eclipse by Mr. and Mrs. Charles W. Thompson of California, and Señores Louis Nebot, Francisco Jodra, Victor Jiemenez, and Esteban Milla, of Almazán.

The observations planned were: (1) Photographs of the corona; (2) a photographic search for intra-mercurial planets; (3) a photograph of the spectrum of each of the flashes, and a photograph of the spectrum of the corona during totality.

For photographing the corona we used four different cameras. The first was a "tintype" lens kindly loaned us by Mr. Spratt of Bloomington. It has an aperture of two and one-half inches and a focal length of eight inches. Three plates were exposed in this camera and on them we hoped

Fig. I. The Polar Axis Carrying the Short Focus Cameras.

to get long, faint coronal streamers. The second was a portrait lens of the Petzval pattern, of five inches aperture and focal length twenty-eight inches. This is an exceedingly good lens and gives superb definition over a small area and is very rapid. In this camera we exposed five plates, varying the exposure from two to 84 seconds, hoping to get detail of the outer corona and in the longer exposures to detect the presence of faint streamers. The lens of the third camera is the visual objective of the old telescope used by the late Professor Kirkwood and others for many college generations. Its diameter is three and one-half inches and its focal

length fifty inches. In this camera we exposed four plates. These three cameras, together with a spectroscope, were mounted on a wooden polar axis that was built at the camp.

The objective of the fourth camera has a diameter of nine inches and a focal length of 60 feet. This lens was constructed by Mr. O. L. Petitdidier. The front lens is of the ordinary crown glass, and the back lens of a boro-silicate flint. Quoting Petitdidier from a letter to the writer: "From the point of view of constants they (the pieces of glass) leave nothing to be desired, as the proportional dispersion is practically the same in all parts of the spectrum, so that we should have a perfect achromatic." When the samples of the boro-silicate came, however, it was found that it had a decidedly yellow tinge. It was found also that its composition was unstable, and that it oxidized very rapidly in the presence of moisture. After a conference with Mr. Petitdidier, however, we decided to have our lens made of the boro-silicate flint, and to seal it in an air-tight box as soon as it was finished, and to open the box only a few days before the eclipse. Petitdidier had much difficulty in polishing the lens, owing to the fact that it oxidized so rapidly. He found after much experimenting, a solution that would remove the oxidation without affecting the surface. It was with some misgiving that we shipped the lens, but we found on opening it that it had not tarnished in two months, and the surface on the day of the eclipse was as perfect as the day the lens was finished. The air was very humid on the days following the eclipse, and the boro-silicate flint had begun to tarnish slightly when the lens was packed for shipment home.

This camera was mounted horizontally and fed with a coelostat. A light-tight tube, the outer and inner walls of which were of white canvas and building paper respectively, and which were separated four inches, led from the objective to a dark room in which the plates were exposed. Neither the plates nor the lens was in contact with the tube. The entire instrument was covered with an A tent of white canvas. The plate-holders containing the plates were fastened to a large hexagon, which the operator could revolve at will upon an axis which was parallel to the earth's axis. It was provided with a stop which enabled the operator to bring the plates for the successive exposures quickly and accurately into position. All the slides had been drawn from the plate holders before totality began. The hexagon as well as most of the mechanical parts of

the coelostat, were designed and constructed by Professor Cogshall. Six exposures were made in this camera, of duration one-half second, two seconds, forty seconds, one minute, fifteen seconds, and one-half second. The plates used were Seed's 27, gilt edge, heavily backed.

If there be intra-mercurial planets, and if they, as do all other bodies of the solar system, move in the plane of the equator of the body around which they are revolving, and, if they are from the sun about the distance

Fig. II. General view of the camp. Intra-Mercurial cameras to the left, the sixty-foot camera in the center and short focus cameras to the right.

required by Bode's Law, the major axis of their apparent paths as seen from the earth on the day of the eclipse should have subtended an angle of 23° and the minor axis about 3°. We decided to photograph this region in duplicate. For this purpose we used six cameras of 136 inches focal length, four of which had an aperture of 3½ inches and were made by Petitdidier, and two of which had an aperture of 3 inches. These were built by the Alvan Clark and Sons Corporation. These lenses were corrected for the minimum focus $\lambda = 4750$, which is well within the region for which the Seed 27 plates, which we used, are most sensitive. All

the cameras were mounted on the same polar axis. They were mounted in pairs, each pair covering in duplicate six and one-half degrees, so that the three pairs covered in duplicate a region along the sun's equator twenty degrees long and six degrees wide. By a series of experiments we had found that a plate exposed in one of these cameras for three minutes and forty-five seconds, at a time when the sky was as dark as

Fig. III. The coelostat and nine-inch lense of the sixty-foot camera.

it was estimated it would be at the time of totality though fogged somewhat by the skylight would show more and fainter stars than if exposed for a shorter time. We had made exposures varying from one to four minutes in the vicinity of Regulus when it was near the meridian beginning when Polaris was just visible to the unaided eye. We decided to expose the plates for the intra-mercurial planet for three minutes and twenty seconds.

The weather on the day of the eclipse was disappointing. For two hours before totality the entire sky was covered by light, though unbroken, clouds. At the time of totality, however, the clouds in the immediate vicinity of the sun appeared to break away, and the inner corona shone through light, drifting clouds. No clear sky was visible, however, within several degrees of the sun, neither Mercury nor Regulus could be seen from this station. During the morning a moderate wind prevailed, the general direction being W. N. W. The first contact was, neglecting seconds, at 11:41. The weather conditions during the eclipse, as observed and recorded by Mr. Thompson were as follows:

Local M. Time.	Temperature.	Direction of Wind.	
11:41	First contact	.....	Very slight wind.
12:00	18°5 C.	N.W.	Very slight wind.
12:15	18.2	N.W.	Very slight wind.
12:30	17.1	W. by S.	Wind dying away.
12:45	16.1	No wind.	
12:59	Totality	began.	No wind.
1:03	Totality	ends.	No wind.
1:06	15.0	S. W.	Very slight wind.
1:15	15.0	W.	
1:30	15.5	W.	
1:45	16.0	W. N. W.	Wind increasing.
2:00	16.5	W. N. W.	Brisk wind.
2:15	17.2	W. by N.	Brisk winds.
2:21	Eclipse	ends.	

Considering the weather conditions, our plates are very satisfactory. The shortest exposure, showing the prominences, suffered very little. The very bright group on the eastern edge of the sun is particularly well defined, and the negatives made of it with the long-focus camera hold a wealth of detail. The longer short exposures with the long-focus as well as the short-focus cameras show considerable coronæ detail, while the longest exposures have that part of the corona uncovered by the clouds much overexposed, while the clouds made it impossible to register any extended streamers. All the plates lack the definiteness that would have

resulted from good seeing. The longest extension of the corona that we obtained was about three-fourths the sun's diameter.

The exposures of one-half second with the 60-foot lens showed the prominences overexposed, while the exposure of two seconds was too short to register more than a suggestion of the inner corona. The exposures given in the 50-inch camera, viz., 24 seconds, 29 seconds, 184 seconds, and 25 seconds, were about right, and the results obtained with this

Manuel, The Carpenter.

lens are more satisfactory than any others with the short-focus lenses. The exposures given in the portrait lens, viz., 2, 24, 29, 84, and 16 seconds, were too long. All plates exposed except the fourth in the portrait lens, which was a lantern slide, were Seed 27, and all were heavily backed to prevent halation. Of the small cameras the negatives of portrait lens, suffered most, because the part of the corona that we hoped they might contain was covered by the clouds. The negatives made with the fifty-inch camera are particularly good and hold a wealth of complex detail. An examination of these negatives shows that the coronal struc-

ture is more complex than in 1900. In particular that the polar streamers instead of being radial, are bent and interlaced, and in every case long coronal streamers are above the prominences.

The plates exposed for the intra-mercurial planets are heavily fogged, as one would expect from a sky covered with bright clouds, but not so badly as to obscure faint star-images. I believe that a plate of the sensitiveness of the Seed's 27, which we used, can be exposed three minutes

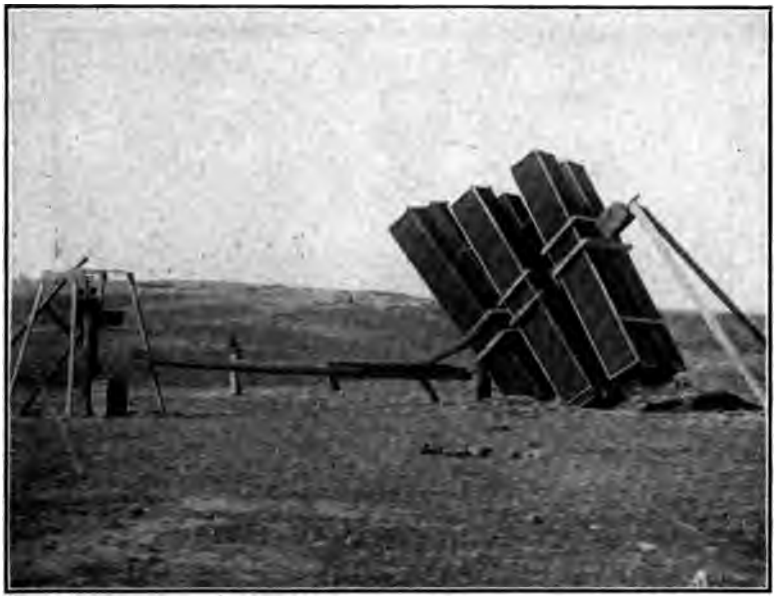


Fig. IV. The Intra-Mercurial Planet Cameras.

without serious fog at a time of a total solar eclipse. Our sky was so cloudy that it is unreasonable to expect star-images on these plates. We examined two of them hurriedly (the ones on which Regulus should have appeared), but found no star-images. The photograph of the corona on one of the intra-mercurial plates showed longer extension than on any other plate we exposed—due perhaps to the shifting of the clouds during the long exposure.

The corona impressed me as being brighter than in 1900. The effect on the clouds of the light from the eclipsed sun was peculiarly striking, and from a spectator's point of view was very beautiful.

The indescribable deep blue of the great clouds, bordered with what any one but an eclipse observer would call a silver lining, was totally unlike anything I have ever seen, and was strikingly beautiful.

The expedition is under many obligations. The Indiana University, The Indianapolis News and the Reader Magazine bore the expenses of the expedition. While the authorities of the university and the managers of the News gave kindly counsel and aid, Professor Cogshall, conjointly with the writer, worked incessantly for the success of the undertaking from the beginning to the end. Messrs. Slipher, Crull and Bulleit were with us three weeks before the eclipse occurred and rendered daily and indispensable assistance; while the entire staff of observers contributed materially to the success of our plans. The Spanish government admitted our instruments free of duty, the alcalde (mayor) of Almazán rendered timely and efficient aid in the selection of the site for our camp, and in the protection of our instruments. Benj. H. Ridgely, American Consul-General at Barcelona, manifested in every way a kindly and intelligent interest in the work of the expedition.

Corona of August 29, 1905, exposure in the Kirkwood 50-inch camera, magnified.

Irrelevant Factors in Bitangentials of Plane Algebraic Curves.

By U. S. Hanna.

Three years ago I presented a paper to the mathematical section of the Academy dealing with the proof of a formula used by Mr. Heal in an article published in the Annals of Mathematics, vol. VI, page 64. This formula was used by Heal in freeing a bitangential of the plane quintic, which he had developed in a previous paper in the Annals, vol. V, page 33, from an irrelevant factor, the square of the hessian of the quintic. Since then I have continued the study of the subject and wish to present an interesting result in the light of Heal's work.

Taking the general equation in the symbolic notation

$$(a_1 x_1 + a_2 x_2 + a_3 x_3)^n = a_x^n = b_x^n \quad c_x^n \quad \cdots = 0, \ldots\ldots (1)$$

for the n-ic and deriving the first polar, with respect to the n-ic, of any point y, we have

$$(a_1 x_1 + a_2 x_2 + a_3 x_3)^{n-1} (a_1 y_1 + a_2 y_2 + a_3 y_3) = a_x^{n-1} a_y = 0, \ldots. (2)$$

Any point on the line through the points x and y may be represented by $\lambda x + \mu y$, where λ and μ have a fixed ratio for any particular point. If x be a point on the n-ic and y be a point on the tangent to the n-ic at the point x, then we have equations (1) and (2) satisfied by the points x and y respectively, and equation (2), as an equation in y, represents the tangent to the n-ic at x. If, in addition to these conditions, the point $\lambda x + \mu y$ lie on the n-ic, we must have from (1)

$$\left\{a_{\lambda x+\mu y}\right\}^n = (\lambda a_x + \mu a_y)^n = 0,$$

from which, by virtue of (1) and (2), we get

$$\frac{n(n-1)}{2!} a_x^{n-2} a_y^2 \lambda^{n-2} + \frac{n(n-1)(n-2)}{3!} a_x^{n-3} a_y^3 \lambda^{n-3} \mu + \cdots +$$

$$n a_x a_y^{n-1} \lambda \mu^{n-2} + a_y^n \mu^{n-2} = 0. \ldots (3)$$

Equation (3) is an (n-2)-ic in λ and μ which gives the positions of the remaining n-2 intersections of the tangent to the n-ic at x with the n-ic itself. In order that this tangent be a bitangent the discriminant of equation (3) must vanish. This discriminant is a function of x and y, and if y

can be expressed in terms of x, then the discriminant becomes a bitangential of the n-ic. It has been shown by Jacobi and Clebsch that this is always possible.

We shall write equation (3) as

$$A_0\,\lambda^{n-2} + (n-2)\,A_1\,\lambda^{n-3}\mu + \frac{(n-2)\,(n-3)}{2\,!}\,A_2\,\lambda^{n-4}\mu^2 + \cdots +$$
$$(n-2)\,A_{n-3}\,\lambda\mu^{n-3} + A_{n-2}\,\mu^{n-2} = 0, \quad \ldots \quad (4)$$

where we have

$$A_0 = \frac{n\,(n-1)}{1\,.\,2}\,a_x^{n-2}\,a_y^2, \quad A_1 = \frac{n\,(n-1)}{2\,.\,3}\,a_x^{n-3}\,a_y^3, \quad \cdots\cdots$$
$$A_r = \frac{n\,(n-1)}{(r+1)\,(r+2)}\,a_x^{n-r-2}\,a_y^{r+2}.$$

If equation (4) is a quadratic, that is, if the n-ic is a quartic, the discriminant of (4) is

$$-\frac{4}{A_0^2}\,(A_0\,A_2 - A_1^2) = 0,$$

and after y is expressed in terms of x there is no irrelevant factor.

If the n-ic be the quintic, the discriminant of (4) is

$$-\frac{27}{A_0^6}\,(G^2 + 4\,H^3) = 0,$$

where we put $H = A_0\,A_2 - A_1^2$ and $G = A_0^2\,A_3 - 3\,A_0\,A_1\,A_2 + 2\,A_1^3$, and the y can easily be expressed in terms of x for the functions G and H, but the result contains the square of the hessian of the quintic as an irrelevant factor. This factor can be discarded without difficulty by putting

$$G^2 + 4\,H^3 = A_0^2\left\{(A_0\,A_3 - A_1\,A_2)^2 - 4\,(A_0\,A_2 - A_1^2)\,(A_1\,A_3 - A_2^2)\right\},$$

and then expressing y in terms of x for each parenthesis separately.

If the n-ic be the sextic, the discriminant of (4) is

$$\frac{256}{A_0^6}\,(I^3 - 27J^2) = 0,$$

where $I = A_0\,A_4 - 4\,A\,A_1, A_3 + 3A_2^2$ and $A_0^5\,J = A_0\,H\,I - G^2 - 4H^3$.

There is no difficulty in expressing y in terms of x for the function I, and therefore, by multiplying and dividing the discriminant by A_0^6, we can immediately write a bitangential of the sextic by substituting the results obtained for the quartic and quintic in

$$\frac{256}{A_0^{12}}\left\{A_0^6\,I^3 - 27\,(A_0\,H\,I - G^2 - 4\,H^3)\right\} = 0.$$

But this bitangential of the sextic contains the sixth power of the hessian of the sextic as an irrelevant factor. In order to free it from this factor, we put

$$J = (A_0 A_2 - A_1^2) A_4 - (A_0 A_3 - A_1 A_2) A_3 + (A_1 A_3 - A_2^2) A_2,$$

and then express y in terms of x for the function J. The work involved in this last step is very long and tedious. These results can be used in developing a bitangential of the septic, but two additional functions will have to be developed, the work in which is almost beyond the range of possibility.

On the Weathering of the Subcarboniferous Limestones of Southern Indiana.

By E. R. Cumings.

The subcarboniferous (Mississippian) limestones of southern Indiana comprise three formations known in the ascending order as the Harrodsburg, Salem (Bedford) and Mitchell limestones, and having a combined thickness of at least 350 feet. These rocks are in the main very pure carbonate of lime. Some shaly layers are to be found in the Harrodsburg and Mitchell limestones which may contain very little lime; and the Harrodsburg is rather lower in the per cent. of lime carbonate than the other two formations. Analyses of the Salem limestone show from 97.9 per cent. to 98.4 per cent. $CaCo_3$, with the balance consisting of magnesium carbonate, and oxides of iron and aluminum, with traces of silica and other substances. Analyses of Mitchell limestone show from 96.65 per cent. $CaCo_3$ to 99.04 per cent., with the balance consisting of magnesium carbonate, iron, aluminum, and silica as in the Salem limestone. Satisfactory analyses of the Harrodsburg limestone are not at hand. Of these limestones the Salem is the most constant in composition and is on the average the highest in per cent. of $CaCo_3$.

In texture the three limestones vary widely. The Harrodsburg is rather thin bedded, coarse-grained, fossiliferous, in some cases decidedly crystalline in structure, and contains geodes abundantly, in the lower portion especially, and bands and knots of chert. There are layers and lenses of shale. The Salem limestone, on the contrary, is, as is well known, almost without bedding planes. It is a massive, oölitic or granular-crystalline, close-grained rock frequently cross-laminated and quite free from geodes and chert. Its fossils are usually minute, foraminifera and small ostracods predominating. The Mitchell limestone is in the main thin-bedded, hard, fine-grained, sometimes almost lithographic, with frequent alternations of shaly layers. It is in general unfossiliferous. Bands and knots of chert are very common, but geodes are infrequent.

All these limestones are conspicuously jointed. The Mitchell shows the cleanest and most numerous joint planes; but the best examples of

deeply opened joints are to be found in the Salem. The joints run nearly east and west and north and south. In other words, one set runs with the dip, and the other with the strike. The dip joints are the most conspicuous.

The weathering of these limestones does not differ in essential features from that of limestones in general, except as it is influenced by local conditions of temperature, rainfall and drainage, and by the exceptional purity of the rocks. It is to be expected that a nearly pure carbonate of lime, in a region of rather copious rainfall and mild climate would weather almost entirely by solution and other chemical processes, rather than by mechanical processes. The limestones in question exhibit the effects of solution on such an extensive scale as to warrant calling particular attention to them; and it is for this reason that the present paper has been prepared. To this end attention has been called to the composition, texture and structure of these rocks, even at the expense of repeating descriptions already many times recorded in the literature of Indiana geology. It is only by understanding the intrinsic nature of a rock that we can correctly appreciate and explain its metamorphism, whether it be in the zone of weathering or in the deeper zones.

The chief agent of weathering in the present case is meteoric water charged with CO_2 and with organic acids (humic acids). The normal annual rainfall in the region under consideration is 42 inches (somewhat more in the southern counties), rather evenly distributed throughout the year. The largest average precipitation has been in the month of July, while the minimum has been in the fall months—September, October, November. The mean annual temperature is 52° F. The topography of the limestone region excepting its eastern and western borders is undulating, and of rather mild relief. Rolling uplands in which the larger streams are rather deeply intrenched are the characteristic features. The conditions are therefore such as to admit of a comparatively copious entrance of water into the rock and free egress at lower levels into the main streams. Such conditions favor solution. Solution has also been favored in the past by the heavily forested condition of the region before its settlement by the white race.

The water which finds its way to lower levels in the rock than can be tapped by the local drainage is frequently returned to the surface along joint planes in the deep valleys on the western border of the region. A notable instance of this is the French Lick Valley, which must derive

its mineral waters, now rendered famous by extensive exploitation, from the uplands of the Mitchell limestone, some fifteen or twenty miles to the eastward. These waters, which reach the deeper zones of flow, are always strongly impregnated with mineral salts. Much of the mineral water of the French Lick Valley comes from a depth of 400 to 500 feet. Owing to the depth to which it descends and distance which it travels, the water has been brought into intimate contact through a considerable interval of time with these eminently soluble limestones and its highly mineralized condition is an evidence of the vast amount of material removed from them, most of which, however, has undoubtedly been derived from a comparatively superficial zone.

The most conspicuous effects of solution are those produced at or near the surface of the rock, and it is these that the photographs presented herewith illustrate. In quarry openings where the rock has been taken down along a joint plane, so as to expose the wall of one of these avenues of ground-water, the effects of solution are shown in greatest perfection of detail. The dip joints are often greatly enlarged, their walls pitted and honeycombed, and traversed by arborescent systems of small openings through which the carbonated waters have eaten their way; and the once solid rock is reduced to a crumbling earthy substance stained and rusted with iron. Where two joints (dip and strike) intersect, the enlargement is apt to be greatest, giving origin to funnels, narrowing gradually downward, and showing in a beautiful way the method of formation of sinkholes, which are only such funnels of solution grown large.

Where the surface of the limestone has been denuded of soil, for quarrying purposes, it is found to be corroded to a remarkable extent. Every dip joint now becomes a ragged furrow, and between joints the rock rises in hummocky ridges, the hog-backs of quarrymen. Points and knobs and mushroom-like projections meet the eye at every turn—bewildering in variety and impossible to describe. The hog-backs frequently stand as high as a man's head, and their flanks are scarred and scored by the all pervasive attack of the dissolving water.

Except where the activities of man or nature have removed it, a blanket of red soil overlies and hides this marvelous complex of corroded rock. The red soil or clay is the minute remnant of the original rock, left after the lime carbonate has been carried away in solution by the water. It is the insoluble residue. So complete has been the removal

of the lime that this residual soil requires the addition of lime to render it fertile. A handful of soil may be treated with acid without giving an appreciable effervescence, even though the soil be taken from within an inch of the limestone. Analysis of this clay reveals about 67 per cent. to 80 per cent. silica, 8 per cent. to 14 per cent. aluminum, 6 per cent. or 7 per cent. iron oxide (Fe_2O_3), and very small percents of lime, magnesia, soda and potash, etc. The iron is responsible for the intensely red color of the clay. The process which has produced this soil is the solution of the limestone with oxidation of the iron which exists in minute quantities in the original rock as a protoxide. The surface of the limestone beneath the soil, besides being rough and ragged as explained above, is usually minutely roughened, though sometimes fairly smooth, especially in the Mitchell limestone. In some cases, especially in the Salem limestone, the rock in contact with the overlying soil is rotted and discolored beyond recognition and shows a graded passage from sound unmodified rock below to soil above. Where layers of shaly rock occur, as in the Mitchell, they are often so rotted that while they retain much of their original appearance and stratification, they may be removed with pick and shovel as easily as any clay. Sometimes a layer of limestone overlying a layer of shale is left as an isolated chain of boulders in the general mass of residual soil. The deepest accumulation of residual soil seen by the writer is in the cut on the Illinois Central Railroad in the northwest edge of Bloomington, where it is 30 feet deep. Usually it is not more than five or six feet deep. Over the Mitchell and Harrodsburg limestones the soil contains chert, and, in the latter rock, geodes in abundance, because of the relative insolubility of these substances. Where blocks of Salem limestone are exposed at the surface to the rain they become deeply furrowed by the solvent action of the rainwater running over their flanks. The faces of old ledges, long exposed to the weather, are scarred and seamed by this action and extensively honeycombed, owing to the unequal solubility of the rock. In these holes and pockets on the rock surface small plants find lodgment and by the mechanical action of their roots and the chemical action of the products of their decay, greatly aid the process of disintegration.

The effects thus far described are seen to best advantage in the exposures of the Salem limestone. The Mitchell shows to a pre-eminent degree the deeper-seated effects of solution in the formation of caverns and underground streams. Everywhere the surface of the country occu-

pied by the Mitchell limestone is dotted over with sinkholes, and the hillsides along the larger streams abound in springs and entrances of caves. Some of the caves, such as Marengo and Wyandotte, have attained wide fame. The Mitchell is, as indicated above, conspicuously jointed but fine grained. The groundwater is compelled to traverse the joints rather than the pores of the rock, and it is this, in the writer's opinion, that has caused the more extensive development of caves in the Mitchell than in the Salem limestone, since the two must be about equally soluble. It is the concentration of solution along joints and bedding planes that gives rise to caves. The Mitchell has both an elaborate system of joints and numerous relatively impervious layers to serve as cave floors. Neither of these conditions would avail, however, without the third condition, adequate drainage, which has been supplied by the intrenching of the main streams as explained above.

No. 1. Hunter Quarry, Bloomington, Ind., showing fresh quarry face to right and weathered joint face to left. Salem limestone.

No. 2. Old Quarry, one mile west of Stinesville, showing weathered joint face. Salem limestone.

No. 3. Honeycombing and etching out of cross-bedded limestone. Old Quarry one mile west of Stinesville.

No. 4. Honeycombing of Salem limestone and lodgment of plants in solution holes. Oliver Quarry, Clear Creek.

No. 5. Weathered blocks of Salem limestone fallen from cliff on Clear Creek, Ind. Oliver Quarry.

No. 6. Detail of a portion of No. 5, showing honeycombing.

No. 7. Large cavities formed by solution. Salem limestone, Big Creek, near Stinesville, Ind.

No. 8. Large cavity formed by solution and frost action. Harrodsburg limestone, near Stinesville, Ind.

No. 9. Old Quarry on Big Creek west of Stinesville, Ind., showing joints enlarged by solution. Salem limestone.

No. 10. Hunter Quarry near Bloomington, Ind., showing joints enlarged by solution. Salem limestone.

No. 11. Old Quarry one mile west of Stinesville, showing joint enlarged by solution. Salem limestone.

No. 12. Joint enlarged by solution and filled with residual soil, near West Baden, Ind. Mitchell limestone.

No. 13. Cut on the C., I. & L. R. R. in northwest edge of Bloomington, showing jointing of Mitchell limestone.

No. 14. Exposure of Salem limestone on Big Creek near Stinesville, showing jointing.

No. 15. Sinkhole. Whitehall pike west of Bloomington, Ind., in the Mitchell limestone.

No. 16. Entrance to Donaldson Cave, Mitchell, Ind., in Mitchell limestone.

No. 17. Corroded surface of Salem limestone. Quarry near Stinesville.

No. 18. Corroded surface of Salem limestone. Oliver Quarry, Clear Creek.

No. 19. Corroded surface of Salem limestone. Quarry near Sanders, Ind.

No 20. Corroded surface of Salem limestone. Quarry near Sanders, Ind.

No. 21. Pinnacles formed by solution. Top of Harrodsburg limestone in R. R. cut on Clear Creek.

No. 22. Block of Salem limestone furrowed by rainwater

Action of Calcium Chloride Solution on Glass.

By P. N. Evans.

In the course of some recent experiments on boiler corrosion the author had occasion to place various dilute solutions in contact with iron wire in glass bottles and heat them in an autoclave containing water up to 200 pounds steam pressure, which corresponds to about 200 degrees Centigrade. The heating was continued for periods ranging from three to seven hours.

The solutions were all about fifteenth-equivalent-normal in strength, and included the following substances, separately: sodium nitrate, ammonium nitrate, calcium nitrate, nitric acid, sodium chloride, calcium chloride, magnesium chloride. In each case 250 cc. of the solution was heated in a 500-cubic-centimeter bottle.

In most cases the bottles were appreciably attacked by the solutions, so that the glass stoppers could not be removed and the bottles were noticeably etched inside, sometimes with the formation of scaly matter on the bottles and in the enclosed water.

The effect was very much the most pronounced in the case of the calcium chloride. The solution was heated for 6 hours in a bottle of clear glass of good quality, weighing empty about 275 grams. On opening the autoclave the bottle was found to have been eaten through near the bottom and the rest largely covered with a gelatinous layer which hardened in a few days to an opaque coating. The piece of iron wire in the solution throughout the heating had gained very slightly in weight and in tensile strength. Also, about 90 grams of loose scaly material was found, and the solution, which had been perfectly neutral, had become strongly alkaline. Apparently fully half of the glass had been acted upon, so that this very dilute calcium chloride solution, containing less than 1.5 grams of calcium chloride, had in about 6 hours chemically attacked over 100 grams of glass.

In seeking an explanation of the results, the various constituents of a calcium chloride solution may be considered. These include, according to generally accepted modern theories, water, calcium chloride molecules,

perhaps some hydrated calcium chloride molecules, calcium ions, chlorine ions, calcium hydroxide molecules, hydrochloric acid molecules, hydrogen ions, hydroxyl ions.

Of these ingredients water can hardly be the active agent, or equally marked results would have been obtained in the other cases; of the other chemical substances present, all but calcium chloride molecules—anhydrous and hydrated—were present in approximately equal quantities in other solutions tested without corresponding results. The action, then, must be considered catalytic, on account of the quantities involved, and induced by calcium chloride molecules, anhydrous or hydrated, and is apparently the hydrolysis of the silicates of the glass, with the formation of more or less hydrated silica and free bases.

Determination of Equivalent Weights of Metals.

James H. Ransom.

Some years ago I presented to the State Science Teachers' Association a description of an apparatus for determining the equivalent weights of the metals. The object was to devise an apparatus so simple and inexpensive that it might be used in every high school. That apparatus, which consists only of a flask and stopper, gives fairly accurate results, and where more complicated apparatus is not available it may well be used instead of giving up the determination of at least one of these most important chemical constants.

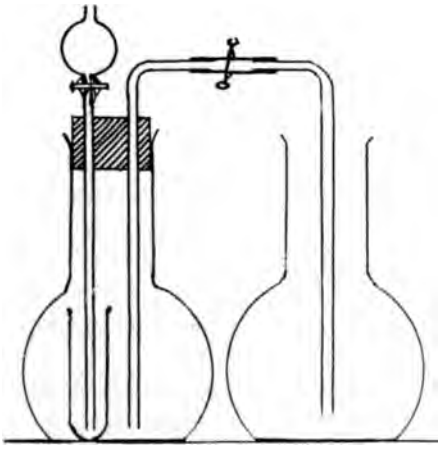
In colleges, however, where a greater variety of apparatus is available, it has seemed desirable to use apparatus which necessitates more care in its adjustment. It is desirable because the student becomes interested in working with complicated pieces, and on that account recalls more vividly the thought back of the method. Also I have found that with the apparatus about to be described the students of average ability obtain results more nearly in agreement with one another and with the theory.

The pieces of apparatus needed are two litre flasks, a two-hole rubber stopper, separating funnel, test-tube, pinch-cock, glass tubing and rubber connection. The accompanying sketch shows the apparatus when ready for use.

A weighed quantity (.6 to 1.0 grm.) of pure zinc is put into a test-tube and this put into one of the litre flasks. The flask is filled with water which has been slightly warmed to expel the dissolved air. The stopper, carrying the separating funnel with the tube long enough to reach to the bottom of the test-tube, and also carrying a tube bent to a right angle and reaching nearly to the bottom of the flask, is adjusted in the flask so that the tube of the funnel will enter the test-tube and reach nearly to the zinc. When pressing the stopper into place the exit tube should be closed with the pinch-cock and the funnel stop-cock opened so that water will fill the tube of the funnel up to the stop-cock or above. Now by allowing water to flow from the funnel

into the flask the exit tube may also be filled with water. When this has been accomplished the apparatus is tested for leaks by closing the stop-cock and opening the pinch-cock. Should there be a leak, water will siphon out. No water should remain in the bulb of the funnel.

When the apparatus is tight an accurately measured volume (15 to 20 cc) of concentrated hydrochloric acid (dilute acid can be used with magnesium) is put into the separating funnel; the exit tube is put into the second flask which has previously had its sides dampened with water. About one half of the acid is now allowed to flow into the tube containing the zinc. A rapid evolution of hydrogen occurs which drives



water over into the second flask. When the action slows down more acid is run in, care being taken that at the end the surface of the acid is just at the stop-cock. When all the metal has dissolved (it may take one-half hour) the surfaces of the liquids in the two flasks are brought to a level by raising or lowering one of them, and while level the pinch-cock on the exit tube is closed. The stopper is now withdrawn from the generating flask and the temperature of the water in it is taken. Also the reading of the barometer is noted. The volume of the water in the receiving flask is carefully measured and from its volume the volume of the acid used is deducted. The remainder is the volume of hydrogen produced during the action. This is corrected to standard conditions, and from the corrected volume and the weight of zinc used

the weight of zinc necessary to produce 11.2 litres of hydrogen is calculated. (11.2 litres of hydrogen weigh one gram).

The accuracy of the method was tested by Mr. Kimerline, a sophomore student in chemistry, who made three determinations each of three metals. The average of the closely agreeing results is as follows: aluminum, 9.02 (theory 9.03); magnesium, 12.08 (theory 12.18); zinc, 32.55 (theory 32.7). In a class of 70 freshmen who had worked in the laboratory only 18 hours, and using horn-pan balances, the average of 37 results picked at random was 31.9.

The apparatus apparently gives good results even in the hands of inexperienced men.

Studies in Catalysis.

By James H. Ransom.

In 1902 there was presented to this Academy by Mr. E. G. Mahin, working in my laboratory, a paper dealing with the action of heat on mixtures of manganese dioxide and potassium chlorate. In this paper it was shown that the nature of the reaction as well as the temperature of decomposition depended on the purity of the oxide, in that the purer and drier the material the higher the temperature of rapid decomposition and the smaller the amount of chlorine and chlorine oxides. The study of this action has been continued by the writer, and some new data accumulated.

Instead of using the purified commercial article, manganese dioxide was prepared in the laboratory by heating chemically pure manganous nitrate to a high temperature as long as decomposition occurred, and then washing out all soluble material. After this treatment the residue was dried for some hours at a high temperature in vacuo. It was then preserved in glass-stoppered bottles in a desiccator. Prepared in this way the oxide is not hygroscopic.

One to two grams of potassium chlorate, free from chlorides, was mixed with about the same weight of the manganese dioxide and the mixture heated in an air-bath, the temperature being controlled with a gas regulator. With the purified material there was observed little or no decomposition at 170° (as Mahin found), and only at 245° to 260° was the action at all perceptible. At 300° to 310° the action completed itself in a few minutes. It was observed that while little oxygen was evolved below 245° the residue gave a test for chlorides, though the tests made before heating gave wholly negative results. Some of the experiments showed less loss in weight during heating than that corresponding to the chloride found by titration against standard silver nitrate. Occasionally, however, the loss was even greater than that calculated so that it was felt that great reliance could not be placed in the difference in weight, especially as the tubes were often heated continuously for some days. The evidence of decomposition rests, therefore, on the formation of chloride.

After these facts were established twenty experiments were performed to find the amount of chloride produced at different tempera-

tures; and to determine, if possible, the lowest temperature at which any chloride would be formed. The temperatures varied in the different experiments between 90° and 200°, and the time of heating from one hour to 21 days. Chlorides were found in each of the 20 experiments, and the amount varied somewhat regularly with the increase of temperature and the time of heating. At 90°-93°, the lowest temperature used, the amount of chloride formed in 14 days was .22 per cent. of that theoretically possible.

In order to show whether the pure chlorate would decompose at all under these conditions some of it was heated in the same manner as that described above. The heating was continued for nine days at 106°-109°. But not a trace of a chloride was produced.

It is interesting to note that decomposition begins 200° below that at which it is sufficiently rapid to be easily observed. But this is in line with the modern idea that the velocity of an action is a function of the temperature. And this observation has its parallel in the fact that 200° below its ignition point hydrogen combines with oxygen in quantities sufficient to be determined.

It has been found also that mixtures of manganese dioxide and potassium perchlorate produce oxygen at a temperature much lower than that necessary to decompose the perchlorate alone. The amount of oxygen is quite appreciable at 310°, but does not become rapid at 360°—a temperature below that at which the perchlorate begins to evolve oxygen.

In order to compare the action of other catalytic agents at low temperatures mixtures of potassium chlorate and platinum black were heated at two temperatures; one sample for 6 days at 145°-150°, the other for 7 days at 95°-100°. Both tubes lost in weight and both gave evidence of considerable amounts of chloride produced. I hope soon to get results at higher temperatures. But at these temperatures manganese dioxide and platinum black are almost identical in their effect on the decomposition of potassium chlorate.

In the near future the study of the action of other oxides at low temperatures will be undertaken in order to get comparative results.

At the beginning of the investigation on catalysis it was believed that many of the actions would prove to be of a purely chemical nature. At the present time there is no evidence that such is the case; but rather that we are dealing with cases of true contact action.

Effect of Radium on Electrolytic Conductivity.

By Ryland Ratliff.

The material used was one-tenth of a gram of "Curie" radium chloride of 10,000 strength placed at the disposal of the writer through the kindness of Dr. Foley and the other Indiana University authorities.

A number of the usual experiments were first performed to test the quality of the material. These included photographing the fluorescent action of the radium upon small diamonds and Wilhemite. In these and kindred experiments good results were obtained.

Two attempts were made to obtain a photograph of the spectrum by means of the Rowland concave and Brashear mounting. In the first exposure of 90 hours the radium chloride was placed directly in front of the slit which was made unusually wide (probably too wide). A second exposure of 162 hours was made by placing the radium slightly to one side of the slit and the fluorescing Wilhemite directly in front of it. In this trial the slit was made narrower but was considerably wider than in ordinary spectrum work. Neither exposure yielded any effect other than a slight fogging of the plate. The remainder of the work was devoted to the problem, as above stated, of determining the effect upon electrolytic conductivity.

The apparatus employed is represented diagrammatically in Fig. 1.

Glass tubes I and II filled with the electrolytic solution are introduced into the two arms of the Wheatstone bridge BD and CD. The copper disks d_1 and d_2 are placed as nearly as possible the same distance apart as d_3 and d_4. Then when resistances R and R_1 are made the same the bridge will of course be balanced approximately. R and R_1 were usually made of from 800 to 1,200 ohms each. With the bridge balanced the radium is placed as near as practicable to I or II and the direction and amount of deflection in each case is noted.

Theoretically the back E. M. F. should be the same in each tube, but it was found to be impossible to get it so in practice for any considerable time. Hence the greatest difficulty in the way of definite positive conclusive results is due to the drift of the needle. A Rowland D'Arsonval galvanometer with a sensitiveness of one megohm was employed in the major part of the work.

The tubes were first filled with an almost saturated solution of Cu So_4. On working for two days with this electrolyte trying many different adjustments it was found that the back or electrolytic E. M. F. was so variable that no reliable results could be secured. The only thing determined positively was that lengthening the distance between the disks in I caused a deflection E, and lengthening that in II produced a deflection W.

On filling the tubes with pure distilled water the results were somewhat more definite. With the disks 1½ cm. apart the following data

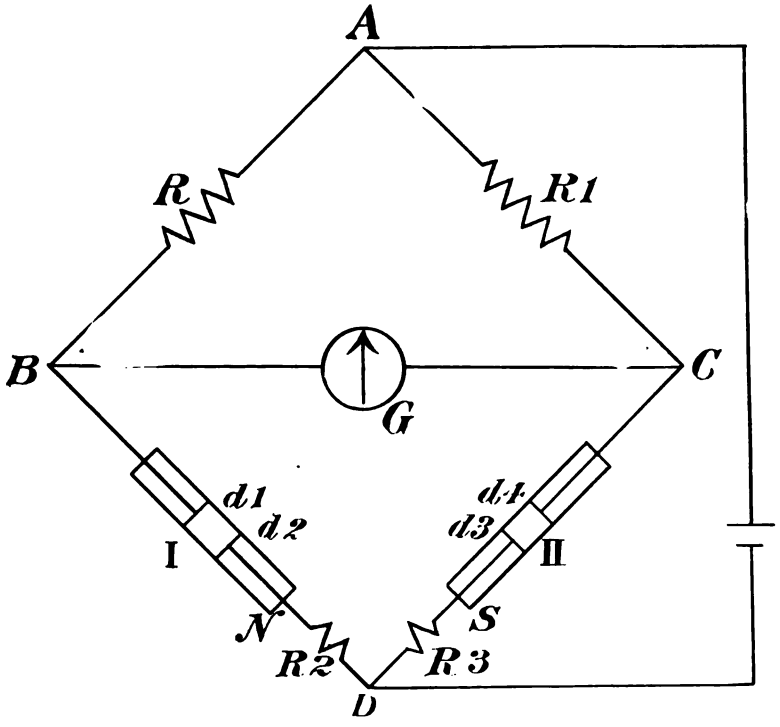


Figure 1.

Dimensions of essential parts of apparatus of Figure 1.

(1) Glass tubes, I and II.
Length of each, 10 cm.
Internal diameter of each, 17 mm.

(2) Copper discs, d1, d2, d3, and d4.
Diameter of each, 16 mm.
Thickness of each, 1 mm.

were obtained: (1) On closing circuit, deflection (W) was first 38, then settled at 22, on standing at 22 several seconds, radium placed nearest II gave deflection (E) to 34½. On removal deflection was W.

Since an E deflection indicates a decrease in the resistance of II the first results secured seemed fairly definite. To make sure the movements were not due to the E. M. F. of the electrolyte, weights were placed on the keys by which the battery and galvanometer circuits were both kept closed for a considerable time until the needle had ceased to drift. Four additional readings were taken, the five sets of readings being as follows: in all the lists of readings deflections indicating a decrease of resistance by the presence of the radium are marked +. those indicating an increase are marked —:

TABLE I.

Reading.	Reading on addition of radium.	Deflection.	Reading on removal of radium.	Deflection.
(1) 22	34.5	+12.5	W	+
(2) 23	42	+19	41.7	+3
(3) 41.4	41.7	+ .3	41 65	+ .05
(4) 41.65	41.65	0	41.65	0
(5) 41.2	41.7	+ .5	41.7	0

Two drops of $H_2S\ O_4$ were added to the water with which the tubes were now filled. This of course greatly increased the conductivity. It also made it much more difficult to balance the bridge. In securing the data given in table II the radium was placed alternately upon the two tubes, N and S.

TABLE II.

Reading at beginning.	Radium on N	Result.	Radium on S.	Result.
33.5	33.5	0	33.85	+ .35
	34.1	— .25	34 5	+ .4
	34.4	+ .1	34.5	+ .1

The results only of the readings will be given in the succeeding lists. The tubes were now enclosed in pasteboard boxes to prevent effects due to light and heat. Each box had a hole just large enough for the insertion of the radium.

TABLE III.

Radium added.	Radium removed.
+ .7	0
+ .10	+ .15
+ .10	+ .13
— .13	+ 2.
— .05	+ .05
+ .6	— .1

It was observed that with a given adjustment the drift of the needle was often tolerably constant, and, for a considerable period in the same direction. Sufficient additional resistance was now introduced at R_2 to cause the needle to drift in the opposite direction so that the influence of the radium would be exerted against the drift.

TABLE IV.

Radium added.	Radium removed.
— .7	+ .9
—1.8	+1.6
+ .4	+2 .5
+3.	0
+3.	—3.

A solution of $AgNO_3$ was next used as the electrolyte. The Ag and Cu made a battery to such a degree that no consistent results could be obtained. A considerable amount of Ag was deposited on the Cu electrodes. Evidently a very dilute solution would be more likely to give results. The most satisfactory solution used was made by diluting 3 cc. of the Cu SO_4 solution used at first to 100 cc.

In Table V the radium was placed alternately upon N and S and readings taken every two minutes.

TABLE V.

Radium on S.	Radium on N.
— .6	— .8
+1 8	+2.
— .7	— .1
+1.6	— .9
— .6	+1.5

TABLE VI.

Radium on S.	Radium on N.
+ .85	— .6
+1.6	—1.15
+ .10	— 75
+ .55	— .25
+ .4	+ .5
+ .2	— .75
+ .25	— .35
+ .5	— .4
+ .15	— 05
+ .5	0
+ .4	— .5
+ .2	— .15
+ .3	0
+ .5	0
+ .35	— 2
+ .10	0
+ .06	+ .02
+ .65	+ .05
+ .15	+ .07
+ .3	— .1
+ .15	— .2
+ .15	0
+ .4	0
+ .25	0
+ .07	
+ .22	
+ .1	
.0	
+ .1	
0	
+ .1	

Several of the lists, especially Table VI, show the effect of the drift of the needle.

A number of efforts were made to overcome this difficulty, none of which were entirely successful.

One entire day was spent trying to get data for a curve which would show the influence of this ever present but very variable factor. In the first four readings of Table VII the drift was taken every five or six minutes and the succeeding readings were with the radium, readings every minute.

TABLE VII.

Time.	Deflection.	Amount of deflection.
6 min.	40.25 to 40.8	+ .17
5 min.	40.8 to 41.3	+ .5
6 min.	41.3 to 41	— .3
5 min.	41 to 41.3	+ .3

	Radium on S. Deflection.	Result.		Radium on N.	Result.
1.	41.3 to 41.6	+ .3	2.	41.9 to 41.9	0
	41.6 to 41.75	+ .15		41.9 to 42.1	— 2
	41.75 to 41.9	+ .15		42.1 to 42.1	0
3.	42.1 to 42.5	+ .4	4.	42.82 to 42.8	+ .02
	42.5 to 42.75	+ .25		42.8 to 42.75	+ .05
	42.75 to 42.82	+ .07		42.75 to 42.68	+ .07
5.	42.68 to 42.29	+ .22	6.	43 to 43.1	— .1
	42.9 to 43	+ .1		43.1 to 43.3	— .2
	43 to 43	0		43.3 to 43.3	0

If the average drift was really no greater than that obtained when special effort was made to determine its amount it was not sufficient to balance the considerable excess of positive readings.

Summary: Of the total number of readings, 61 per cent. indicated positive results, 26 per cent. were negative, and 13 per cent. were zero, i. e., gave no deflection. Of the total amount of the deflections (omitting the rather questionably large ones in Table 1), 82 per cent. were positive and 18 per cent. negative. Including those of Table 1, 90 per cent. were positive.

A Simple Method of Measuring Electrolytic Resistance.

By R. R. Ramsey.

In measuring the resistance of electrolytes the back e. m. f. or polarization of the cell is always a troublesome source of error. The potential of the terminals of an electrolytic cell is never the same unless the temperature, concentration, and purity are absolutely the same at both electrodes. To avoid this error various methods have been used, such as the alternating current and telephone method.

While working with electrolytic cells it occurred to me that the ever-present and troublesome e. m. f. might be utilized in a very simple manner for resistance measurement. This method consists of placing the

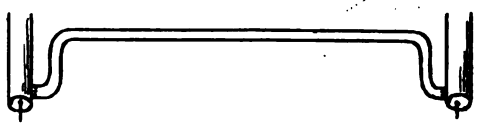


Figure 1.

cell in series with a resistance box and mirror galvanometer and taking readings of the galvanometer deflection with several resistances in the box. From these readings the cell resistance can be determined by solving for Rc in the two equations,

$$Kd_1 = \frac{E}{R_1 + Rg + Rc}$$

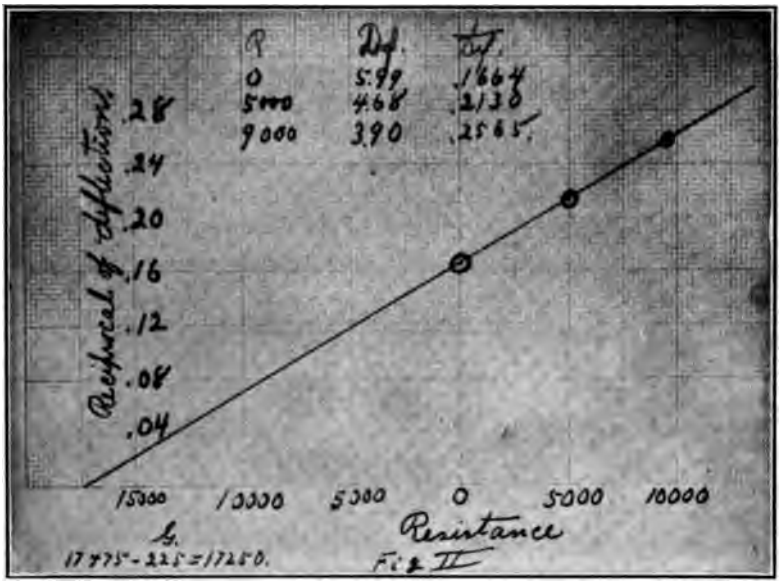
and

$$Kd_2 = \frac{E}{R_2 + Rg + Rc}$$

Rg, the galvanometer resistance being known. A preferable method is to plot box resistance as a basis and the reciprocals of galvanometer deflection as ordinates. The intercept on the X axis being Rc + Rg, from which Rc can be found.

The specific resistance can be found from the resistance and the dimensions of the cell which can be determined by filling with mercury or water.

The cell was made as in Fig. I, the electrodes being made of cadmium amalgam. By placing the two ends in water baths the two ends can be kept at a constant small difference of temperature, thus keeping the e. m. f. constant. The following data and curve (Fig. II) are for a cell filled with 10 per cent. solution of cadmium sulphate.



Length of cell	99 cm.
Cross section	.277 sq. cm.

Box Resistance.	Galv. Def.	$\frac{1}{\text{Def.}}$
0 ohms.	5.99	.166
5000	4.68	.213
9000	390	.256

From curve $Rc + Rg = 17470$ ohms.

$Rg = 225.$

$$\text{Sp. Resistance } \rho = \frac{17470 \times .277}{99.} = 48.3 \text{ ohms.}$$

Some Peculiarities of Electric Sparks Across Short Spark Gaps.

By R. R. Ramsey.

Bloudlot, in his work on N-rays, used a very feeble spark gap. In our attempts to repeat Bloudlot's work Mr. W. P. Haseman and I found some very interesting phenomena which affected the sparking distance and consequently the intensity of the spark. The fact that we were not able to repeat Bloudlot's experiments has led me to make some further investigation.

T. J. Bowlker (Phil. Mag., 8, p. 487, 1904), has worked with long spark-gaps, 1 cm. to 10 cm. in length, and has obtained some very curious results.

The work here described was with a spark gap between platinum wires .45 mm. in diameter and never more than ½ mm. apart.

The spark-gap was provided with a micrometer so as to make length anything desirable. The gap was connected to the secondary coil of a 1-inch induction coil. The current in the primary coil was cut down by means of resistance until the sparking distance was very small. The gap was opened to the point where the sparking just ceased and the effects of various objects were tried. When one's hand or finger was brought within 1 cm. of the gap the sparks appeared. This was attributed to heat. A lighted match had the same effect as did one's breath or a current of hot air. A rod of glass or of brass which had been in the same room caused the effect. Any object brought near the gap caused an increase of the number of sparks.

A No. 20 copper wire 15 cm. long caused an increase when brought near the gap or when it was allowed to touch one of the electrodes a short distance from the gap. The effect was more noticeable when the wire was in contact with the negative terminal. Touching the electrode five centimeters from the wire had no effect. The effect was more marked when the wire was at right angles to the gap than when placed parallel to the gap.

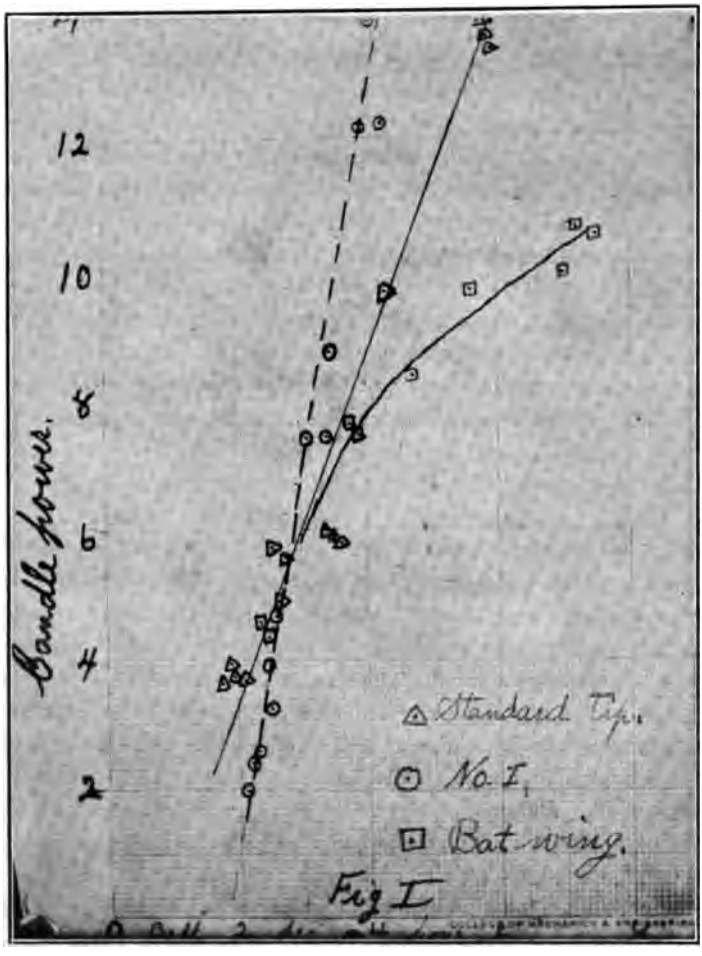
Gas Burners and Standards of Candle-Power.

By R. R. Ramsey and Hiromitsu Oi.

It seems to be taken by common consent that 16-candle-power gas means that the candle-power of the lamp burning the particular gas should be 16 candle-power when the rate of consumption is 5 cubic feet per hour at 1-inch water pressure. The kind of burner used is more or less an open question. The fishtail burner is specified by some of the older authorities. The common practice of gas companies seems to be to use an Argand or circular burner with a chimney. The question "What is the candle-power of the gas?" is one of considerable moment at the present time. Dr. Foley, of the Department of Physics, Indiana University, has been employed by the city of Bloomington during the last two years to make monthly reports of the gas supplied to the city. As a result of these measurements suit has been brought to annul the franchise of the gas company. Indianapolis has its gas troubles. Almost every city seems to have more or less trouble with gas. The fact that the burner used on the Bloomington gas company photometer gave higher values than a standard fishtail burner and that commercial Argand burners gave results consistent with the fishtail burner, suggested the experiments which were carried out by Mr. Oi. The work consisted in changing the air supply and the number of openings in the commercial Argand gas burners and comparing the candle-power to the candle-power given by the standard fishtail. The Argand burner used had 36 openings in a circle of 2.2 cm. diameter and used a chimney 5 cm. in diameter. The one used by the gas company had 24 holes in a circle $\frac{2}{3}$ the diameter of the commercial burner, and used a chimney $\frac{2}{3}$ the diameter of the commercial chimney. The air supply in the burner was largely through the center, while the commercial was supplied about equally inside and outside the cylindrical flame. The supply of gas was regulated by regulating the pressure of the gas by an automatic regulator. The results will be given by means of curves where candle-power is plotted against the consumption in cubic feet. Since the quality of the gas was variable a curve for the standard fishtail was taken for each set of observations. Fig. I gives the curves for three burners with the actual values shown by points. The points in triangles △ are for the standard

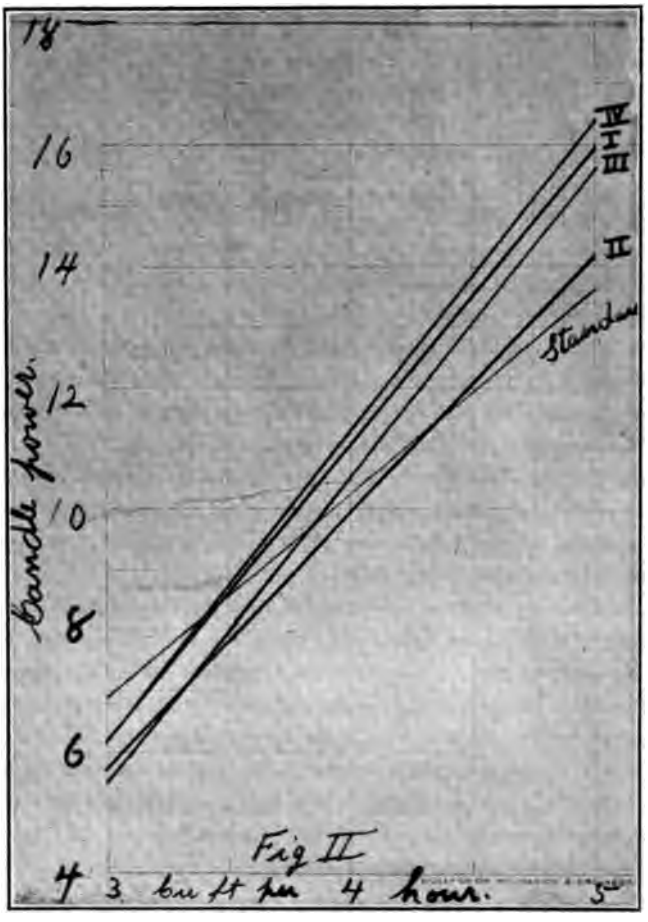
fishtail tip. Points in squares ⊡ are for a slotted lava tip or bat-wing burner. Points in circle ⊙ are for Argand burner No. 1.

In Fig. II are the mean values reduced to a standard basis, namely, 13.6 cubic feet gas, the mean values of the gas throughout the experi-



ments as shown by the standard fishtail burner. Burner No. I was a commercial burner, with the air supply almost all cut off from the outside of the cylindrical flame. Burner No. II was a commercial, with the holes closed with copper plugs, or 18 holes open. Burner No. III had one-

third the holes closed, or 24 holes open. Burner No. IV had 24 holes and almost all the outside air cut off. No. V was a combination of Nos. I and III. From the curve we see that with 13.6 candle-power gas (standard tip) No. II gives 14.2 candle-power, No. III gives 15.6, No. I gives 16 candle-power, and No. IV gives 16.4 candle-power.



If by simply manipulating the burner 13.6 candle-power gas can be raised to 16.4 candle-power, or 20 per cent., it is high time that some definite and authoritative action is taken to define the standards for gas measurement.

Preliminary Notes on an Almost Extinct Native Disease. Trembles or Milk-Sickness.

By Robert Hessler.

(Abstract.)

The paper gave a detailed account of a five-year search for the cause of the above named affection—known as "trembles" in animals, or as "milk-sickness" when transmitted to man by the milk of an affected animal or on eating the flesh.

The disease was formerly common and severe, but today cases are seldom seen. Five years ago a number of cattle were affected and died. a farmer's family also suffered after using the milk of a cow whose calf died of the trembles; the family recovered.

In the fall of 1905 two horses grazing in an infected area became sick; one died, the other recovered under active medicinal treatment. From the blood of the latter pure cultures of a fungus were obtained. (Cultures in tubes were exhibited.)

On the first examination, October 10, 1905, the blood contained spore-like bodies in abundance and small yeast-like bodies enclosed in polynuclear leucocytes; the former rapidly decreased and disappeared in a few days, while the yeast-like bodies increased and later on diminished and disappeared by the time the horse recovered (November 19).

Drawings of the organisms in the blood and of cultures in hanging drops were shown. The pathogeny is now being worked out; the occurrence of the fungus in nature (in certain wet shaded ravines) will be investigated in the future.

Notes on the International Botanical Congress of 1905.

By J. C. Arthur.

International botanical congresses have been held at different times during the last half century. They have originated under various auspices, and for various purposes, but until the one held in Vienna during the last summer none had had direct connection with a preceding congress. Heretofore at each such gathering papers have been read, suggestions made, and resolutions passed, but no mandatory power was exercised. For want of a stable and self-perpetuating organization based upon a system of representation having the approval of botanists in general, it has been impossible to make rules for guidance in any line of botanical activity which any large number of botanists would accept as authoritative.

At the congress held in Paris in 1900 steps were taken to make the organization a permanent one, the proper officers and committees were appointed, and the adjournment was taken to meet again in Vienna in 1905. There are many ways in which a properly constituted body speaking with authority could be of inestimable service in directing the activity of the botanical world. But in one matter there has been for a long time a practically unanimous opinion. It is believed that only by means of such an organization can order be brought out of the present state of confusion, annoyance, and endless discord that exists in regard to the "hispid question" of nomenclature. For a long time modern botanical nomenclature was guided by the dictum of the De Candolles, representing the French people, and the Hookers, and in America Asa Gray, representing the English people. But as knowledge and the numbers of workers increased the subject became too great to be dominated by individuals, and control passed to the great centers of activity, Berlin for the Germans, Kew for the English, Geneva for the French, and what has been denominated the Neo-American school, with its center in New York, for most Americans; although a few strong individual workers still are able to be heard in opposition to all of these. The convenience of a uniform set of names for plants, and the inconvenience of repeated

changes and lack of recognized authority, are too great to let this confused state of affairs continue indefinitely. The hackneyed theme of nomenclature was therefore a prominent incentive for the establishment of an international society, and in the arrangement of its first deliberate program received large attention.

The meeting at Vienna began on Sunday, June 11, 1905, with the opening exercises of the exhibition held in connection with the congress. This was a large exhibition and very attractive and interesting, both to botanists and the general public. It contained extensive displays of apparatus, books, charts, colored plates, special herbarium sets, dried and living fungi and algae, pure cultures of various kinds illustrating particular kinds of investigations, historical matter, such as manuscripts, portraits and the working outfit of early botanists, and numerous other classes of objects, too many to be even enumerated. Each morning of the following week a demonstration in some line of work made a valuable feature in itself. Probably no single botanical display has ever equalled this one in the variety and value of its objects or in sustained interest.

The formal opening of the congress took place on Monday morning in the great hall of the university with much ceremony and pomp. In the afternoon the nomenclature section of the congress was organized in the lecture room at the botanical garden. Every morning and afternoon during the remainder of the week the congress listened to scientific papers by eminent scholars of Europe and America, and every afternoon for five days the nomenclature section met promptly and worked late in a most methodical, businesslike manner, trying to solve some of its problems.

The social events of the week were a notable part of the congress. They opened with a reception on Sunday evening; and every evening following had receptions, parties at the opera or in the park or at the Rathskeller in bewildering profusion. Many short excursions to places of scientific interest were also arranged for the latter part of some of the afternoons. The visiting ladies, presumably not deeply engrossed by the scientific side of the congress, were taken out for drives and to visit art galleries, etc., in the forenoon, attended teas and listened to music in the afternoon, and joined the men in the evening. Among the social features must be classed the long excursions arranged by the congress, a number preceding, and others following the week of the sessions, each occupying from a few days to a month or more.

All the events and exercises of the congress, unless we except the nomenclature section, bore a close resemblance to the large gatherings of scientific bodies which are now common on both sides of the Atlantic. The deliberations over nomenclature partook much more of the nature of a business organization. Each participant was the accredited representative of one or more botanical establishments or societies, or was a government representative, and was entitled to a corresponding number of votes. Each participant had before him a quarto pamphlet of one hundred and sixty pages, printed in four columns. This had been prepared by a commission appointed at the Paris congress of 1900. In one column were the rules of nomenclature adopted at the Paris congress of 1867, which have been the only general rules for guidance in the naming of plants botanists have so far had, which by the growth of the science greatly needed revision, if indeed they did not require complete rewriting. In another column were the modifications or additions suggested by various societies and individuals since the appointment of the commission. The third column contained various comments, and the fourth column embodied the recommendations of the commission. This guiding document was wholly in French, and the official language of the congress was also French. On each side of the presiding officer sat a vice-president, one repeating motions and remarks in English, and the other in German, whenever deemed necessary, that all might fully understand the proceedings and vote effectively. No language was barred in discussion, but practically only French, German and English were heard, and these in nearly equal proportion.

Great earnestness was manifested; this with the lively debate, rapid passage of motions, and the strain of listening to three intermixed languages made it a memorable occasion to the hundred or more participants. But the interest was deeper than the surface or the day. The most influential workers in systematic botany, with the exception of Englishmen, who stand strangely aloof from participation in any organized efforts, were lending their best endeavors to effect a substantial advance in nomenclatorial practice. From the American standpoint the results were not all that were hoped for, action being particularly conservative. But there has been a distinct advance, and of such a nature that the evolution of a substantial system is confidently assured through the future activity of the society.

The first action of the organized body was to exclude cryptogams, mosses and liverworts from present consideration and place these groups in the hands of a special committee for a future report. A committee was also appointed to consider the nomenclature of fossil plants. In the main the rules of 1867 were approved, and the working of the law of priority strengthened. What to Americans seem like undue concessions to the old order of things were the decisions to exempt from the rule some 400 generic names now in use, and to disqualify specific names which duplicate the generic name, as Linaria Linaria, etc. It was voted by a moderate majority that beginning with 1908 descriptions must be in Latin to constitute publication, except in works whose publication was begun before that date and not fully completed. It is believed by American botanists that the greatest shortcoming of the congress was the failure to recognize the value of generic types, which constitute an advance in systematic methods that is certain to find favor as soon as well understood.

The proceedings of the congress will appear in due course of time in two printed volumes, the first containing the decisions regarding nomenclature, and the second the scientific papers read.

If one were to name the most important achievement of this congress, it would undoubtedly be the promotion of fraternity among active botanists in such a manner as to lead to effective organization. Over 600 members of the congress were registered, of which fully two-thirds may be denominated professional botanists, and half of these were men whose names are known to everyone familiar with current botanical literature. It was a more truly representative gathering than ever before discussed botanical problems of world-wide interest. Those in attendance considered the meeting highly successful, and this spirit of good-will toward the movement for a permanent authoritative organization is one of the bright auguries for the advancement of botanical science in many ways. The next meeting of the congress will be at Brussels in 1910, and the meeting following that may confidently be expected to be held in America.

Methods Employed in Uredineal Culture Work.

By Frank D. Kern.

The first researches which proved a positive relationship between the different fruit-forms of the Uredinales not only played an important role in the classification of these fungi, but invested a further study with much interest. A flowering plant which would produce even two separate and distinct sorts of fruit would indeed be a curiosity, and yet these parasites exhibit from one to four kinds of fruiting bodies, and many of them, seemingly to vary their existence, possess the power of living upon two entirely unlike hosts. Further attempts at classification, as well as all economic efforts to control the pests have demonstrated a necessity for a more intimate knowledge of the life-history of these parasitic plants. The connection between the different stages in a life cycle is best shown by means of cultures, and the scientific importance of these inoculation experiments can not be overestimated.

Among the immediate advantages to be gained is the connecting of unattached aecia with their later stages, and to ascertain the range of hosts. Some rusts are doubtless restricted to single species of hosts, both for their accial and telial forms, but since cultures have shown that some heteroecious species may have their aecial hosts belonging even to different families of plants, it is evident that exact relationships can be established only by morphological characters and field observations, affirmed by artificial cultures. In the autoecious species it is sometimes impossible to tell how many spore forms there may be. Such a specimen can not be placed in its proper species on account of the close resemblance of some isolated spore forms. Cultures offer a ready solution to this problem.

Although the various processes in the cultivation of the rusts are comparatively simple, so little has ever been said regarding the apparatus and methods employed that a more detailed account does not seem out of place.

The spring months are the period when most of the work must be done, as this is the normal germinating period for the resting spores, and

is also the active growing season for the host plants. Any sort of spores can be employed for the experiments and the methods vary accordingly. A smaller portion of the work, with urediniospores and teliospores which germinate at once, may be carried on through the summer months and early autumn.

The best success has been attained through the sowing of teliospores which give rise to pycnia and aecia in turn. All grass and sedge rusts furnish telial material, and since they are, with a single exception, known to be heteroecious, any collection affords culture material. Teliospores are usually resting spores and normally retain their viability through the winter. Collections made in the fall and kept in a warm, dry room during the winter usually fail to germinate. The freezing temperature of the outdoor atmosphere does not seem to be detrimental, and some plan to prevent the specimens from thoroughly drying is a necessity. Cloth packets are to be preferred to paper, as they do not take up moisture so rapidly and allow a better circulation of air. These packets may be hung out of doors, or an unheated shed without a floor seems to furnish good conditions. The material put up in this manner may be sprayed occasionally in the fall and winter, but an effort must be made to keep them in a uniform condition. Collections made in the early spring after they have wintered over in the field usually show vigorous germination. Late spring collections are of less value, as the most vigorous are liable to have grown in the field. Spores collected as early as July and August have been brought to germination and have been sown with success, but October and November collections survive through the winter better. In the spring the packets are brought into a warm room some little time before conditions outside are favorable for growth, and after a few days of warmth and moisture some of the spores will show signs of growth. The packets may be sprayed and thrown together in heaps, but they must be spread out and aired and caution taken to prevent molds from starting. The material in germinating condition is carefully separated from that not yet ready to germinate.

If negative results are to be given any weight the spores must be tested just before a sowing is made to ascertain if they are in germinating condition. Teliospores of Pucciniaceous species are tested by means of a hanging drop culture. In a space of twenty-four hours viable spores push out germinating tubes which are readily made out with the

microscope under the ordinary high power. Melampsoraceous species are best tested in a moist chamber, such as a Petri dish, without being removed from the host. Growth can be detected by the unaided eye, or with a hand lens, by means of the light yellow sporidia which cover the sori, making them appear pulverulent instead of waxy. Teliospores of such species as the Coleosporiums germinate as soon as mature, which is in the fall of the year. They are sown when fresh and if suspended over a slide in a moist chamber, the sporidia drop upon it, and their germination can in turn be observed with the aid of the microscope.

For indoor experiments, small but vigorous growing potted plants are used as trial hosts. Since the pots must be handled, it is desirable to select plants with as small roots as possible and still have them maintain their vigor. The tops are placed under bell-jars when the spores are sown, and in order to have them cover more readily all extra foliage is carefully pruned away. A few young and vigorous leaves are all that is required.

The manner of applying the spores to the plants differs slightly according to the kind of spores. If they are aeciospores the leaves bearing the aecia are suspended over the portions to be infected, in such a manner that as the spores fall from the cups they will light upon the desired area. In all cases the host plant is first sprayed, the parts which will not wet being rubbed with the fingers until water will adhere. The spores do not need to be placed in water, in fact they should not be. Teliospores readily begin the germination process in water but seldom form their sporidia there. A moist surface and a saturated atmosphere are necessary factors for the germination of all kinds of spores. Urediniospores and teliospores are removed with a knife or scalpel blade, care being taken to apply the edge to the sorus in such a manner as to loosen the spore by breaking the pedicle, leaving the cell-wall uninjured. If certain areas to which the spores are applied be marked by pieces of thread the watch, which must be maintained for the first sign of infection, will be greatly facilitated.

To secure reliable results, it must be positively made out that a plant is free from infection when a sowing is made. Wild or native plants brought in from the field or garden should remain in the greenhouse a period of eight or ten days so as to preclude a possibility of outside infection.

After the application of the spores the whole plant is covered with a bell-jar and set in a shaded place for a period of three days. The bell-jar prevents rapid evaporation, thereby securing the necessary condition of moisture during the germination time of the spores. A certain amount of warmth is desirable, but during the whole period the plants should be screened from the direct rays of the sun. The bell-jars are temporarily removed each day to allow a change of air and are sprayed on the inside with an atomizer before being replaced. After the second day the plants can be sprayed, but previous to this there is danger of washing away the spores before there has been an opportunity for infection. On the third day the bell-jar is removed and the plant changed to a location where there is more light, in order that growth may be more normal and observation made easier.

A label, bearing the date of the sowing and the name of the species of rust, is a very valuable aid to the observer of results. If the infection is a successful one the first signs are usually noticeable in five to ten days, although some species require fifteen days or even longer. Ordinary Puccinia and Uromyces species, such as the grass and sedge rusts, usually develop pycnia in six or eight days, the aecia following about an equal length of time. Some species, having only teliospores, show signs of infection in four or five days by means of yellow spots, requiring twelve to fourteen days to develop spores. Uredinia sometimes do not follow the sowing of aeciospores for a period of fifteen days or more, while they will reproduce themselves in five or six. The Gymnosporangiums show pycnia in a few days and the mycelium may keep on producing pycnia for a considerable period, but a month or two passes before the aecia appear. Many of the species which produce their aecia on the evergreens germinate their teliospores in the fall, but there will be no visible sign until the aecia develop the next spring, as the pycnia are very inconspicuous.

The procedure throughout is a simple one. No sterilization is necessary, only care and cleanliness. The bell-jars are ready for use a second time after a thorough washing. All organic matter should be removed so as to avoid the starting of molds. No bits of rusted material can be left on the pots or shelves near the plants without the liability of a stray infection. As soon as a developing spore form becomes mature it should be removed for the herbarium or separated from the plants not yet showing infection. In all cases where it is the object to test the range of a

species it is always wise to carry a controlled experiment with as nearly similar conditions as possible. A success in one case and a failure in the other can then usually be relied on as representing the actual state of affairs. If a plant fails to show any results within the reasonable time it is best not to use it again until a sufficient number of days of grace have passed, as there is always a possibility of a belated infection.

It will be seen that care in execution and accuracy of observation are the main features in this work, costly apparatus not being required, and it is hoped that this brief description of the operations may be of service to those interested in this modern method of studying and classifying this group of fungi.

The Embryology of Melilotus Alba.

By W. J. Young.

In the space assigned to this paper it will be possible to give but a brief outline of the development and nutrition of the flower, embryo sac and embryo, trusting to the plates to make clear the points not sufficiently explained in the text.

In the flower of Melilotus alba, the common white sweet clover, there are two factors which interfere with the orderly successive development of the floral organs; the one is mechanical and is due to the crowding of the flowers on the side of a stem axis, the other is physiological and ecological and depends upon the relative use of parts at different times in the development of the flower; the one interferes with the simultaneous appearance of the parts of the same cycle, the other with the acropetal succession.

Melilotus forms an exception to most of Leguminosae so far examined, since the megaspore mother cell develops into the embryo sac without first undergoing tetrad division. The development of the latter differs from typical cases only in details. When the eight-celled stage is reached, the embryo sac elongates rapidly toward the chalaza at the same time curving strongly, and the three antipodal cells disappear. The egg cell occupies a position lateral to the synergids. The polar nuclei lie close together near the egg apparatus. Their fusion takes place just prior to fertilization, before the pollen tube reaches the ovule.

After fertilization the primary endosperm nucleus undergoes several divisions before the egg cell begins to divide. The latter then undergoes two transverse divisions, resulting in a terminal cell which develops into the embryo and two other cells which give rise to a conspicuous suspensor. The embryo follows in the main the Capsella type of development, but with two important differences, viz., much later differentiation of the dermatogen, plerome, and periblem, and the absence of a hypophysis derived from the terminal cell of the suspensor.

Lack of space prevents more than the merest glance at the facts observed regarding the nutrition of the embryo sac and embryo. In its

earliest stages, the embryo sac grows at the expense of the tissue of the nucellus. As it becomes mature it is surrounded by a definite layer of active looking cells, derived from the inner integument, forming a nutritive jacket. This stage is characterized by the storage of reserve food to supply the rapid growth which follows fertilization. Starch is deposited in the placenta and very abundantly in the micropylar region of both integuments. The funiculus contains no starch, since it is the path by which food material enters the ovule and it is important that it should not be blocked by a store of reserve food.

After fertilization the nutritive jacket becomes even more strongly developed, especially in the chalazal region on the side of the sac nearest the funiculus. The cells of the inner layer have a characteristic appearance. They are rounded and turgid, their protoplasm is vacuolated and forms a thick layer lining the inner ends of the cells. They give evidence of great activity which would seem to justify the conclusion that they are the cells most concerned at this time in the nutrition of the embryo sac. Later there appears in this region a thick mass of endosperm which, acting as an haustorium, rapidly digests and absorbs all tissue with which it comes in contact, and the nutritive jacket is naturally the first part destroyed. The location of the starch-bearing and non-starch-bearing areas at this stage seems to justify the following conclusions: Food material enters the ovule in solution and is partly stored up and partly passed on to the chalazal region of the embryo sac. Moreover the stored-up food supply is drawn upon by the nutritive jacket in the chalazal region. Starch does not appear in the embryo until just before the cotyledons appear, when a small quantity is found in the base of the embryo and also in the suspensor. In later stages there is a scanty supply of starch in the periblem.

In the latest stages examined starch was found in varying quantities in all parts of the tissue outside the embryo sac. The ovule, which might now be called the seed, was surrounded by a thick membrane of columnar cells extending even across the funiculus. Inside this columnar layer in the region of the funiculus is a flattened, fan-shaped mass of tracheid-like cells of irregular form having reticulate markings on their walls. These absorb food material through the funiculus and pass it on to the surrounding tissues, and especially through a vascular bundle, the raphe, to the chalazal region of the embryo sac. Surrounding the tracheid-

like cells in the later stages are large cells separated by intercellular spaces, which contain, besides starch, rather large granules which give the test for proteids.

Summary and Conclusion.

The following conclusions result from the above observations:

1. The order of appearance of the primordia of the floral organs is sepals, stamens, carpel, petals, although the last three may appear simultaneously.

2. The energy of the plant is directed at first to the development of the stamens and carpel at the expense of the petals.

3. The archesporium becomes differentiated at a rather late stage.

4. The tapetum divides but a limited number of times.

5. The megaspore mother cell gives rise to the embryo sac directly.

6. The early development of the embryo sac is typical.

7. The antipodals disappear at a very early stage.

8. The embryo sac increases much in size before fertilization and replaces all the tissue within the integuments.

9. The egg cell is placed laterally to the synergids. The latter have striated tips.

10. The polar nuclei do not fuse until just before fertilization. The latter is a rapid process.

11. The ovule is at first anatropous, later campylotropous.

12. The fertilized egg does not divide until there are several endosperm nuclei in the embryo sac.

13. In the three-celled proembryo the terminal cell gives rise to the entire embryo and the second cell to the mass of the suspensor.

14. The early stages in the development of the embryo are of the Capsella type. The dermatogen, however, appears at a later stage.

15. There is no hypophysis.

16. The embryo sac is nourished by means of a nutritive jacket derived from the inner integument.

17. The food material which enters the ovule through the funiculus is partly deposited in the surrounding tissues and partly passed on to the chalazal region of the embryo sac.

18. A mass of endosperm in the chalazal region of the embryo sac acts as an haustorium in the later stages and digests the surrounding tissue.

19. After the formation of the seed coat nutritive material passes from the parenchyma of the funiculus by diffusion through the columnar cells of the seed coat into the tracheid-like cells, which partly distribute it to the surrounding tissue and partly pass it on through a vascular bundle to the chalazal region of the embryo sac.

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Explanation of Figures.

1. Stem tip (a) showing origin of flowers (f) in axils of bracts (B) X 125.
2. Stem tip, later stage, showing origin of flowers and the primordia of the floral organs; (f) flower, (B) bract, (S) sepal, (St) stamen, (c) carpel. X 125.
3. Single flower at a slightly later stage when the petal (P) appears. X 125.
4. Still later stage, indexed as above. The stamens and carpel are enlarging while the petals remain small. X 125.
5. Later stage, the cavity of the ovary appearing; (M) microsporangium. X 125.

6. Still later, the ovules (O) have appeared. X 125.
7. Transverse section of a bud at about the time the embryo sac begins to enlarge; (S) calyx, (P) petals, (St)) stamens, (c) carpel, (Pl) placenta, (V) vascular bundle. X 75.
8. Longitudinal section of carpel, same stage as Fig. 9. The microtome section included about the area between the lines a'b'. X 345.
9. Section of carpel along the line ab, Fig. 8. The folding together of the sides is nearly completed. X 345.
10. Young flower showing nearly simultaneous appearance of petals, stamens and carpel. X 125.
11. Young ovule, sporagenous tissue not yet differentiated. X 1460.
12. Archesporial cell. X 1460.
13. Spore mother cell and tapetum. X 1460.
15. Embryo sac, two-cell stage. X 1460.
16. Embryo sac, four-cell stage. X 1460.
17. Embryo sac, eight-cell stage. Cells of egg apparatus cut from the remainder of the sac. Antipodals beginning to degenerate. X 1460.
18. Young egg apparatus before differentiation of egg. X 1460.
19. Mature embryo sac. The egg cell lies back of the synergids. Polar nuclei fusing. X 1460.
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21. Embryo sac immediately after fertilization. Neither the egg cell nor the primary endosperm nucleus has divided. (S) synergid. X 610.
22. First division of primary endosperm nucleus. Egg cell still undivided. X 1460.
23. First division of primary endosperm nucleus. Telephase. X 1460.
24. Proembryo of two cells. X 610.
25. Proembryo of three cells; (s) synergid. X 610.
26. Same stage as Fig. 25 showing endosperm with radiating character of the protoplasm surrounding the nuclei. X 610.
27. Embryo of two cells. X 610.
28. Embryo of eight cells. X 610.
29. Embryo composed of two layers of cells. X 610.
30. Embryo at a little later stage when the dermatogen begins to be distinguished. X 610.

31. Embryo just before appearance of cotyledons. X 610.
32. Embryo after appearance of cotyledons; (Ple) plerome, (Per) periblem. X 125.
33. Base of embryo of about the same stage as Fig. 32 showing plerome, periblem and relation of embryo to suspensor. X 610.
34. Young ovule of anatropous type. X 125.
35. Ovule at time of fertilization, campylotropous type; (N. J.) nutritive jacket. X 125.
36. Ovule a short time after fertilization, showing the curvature of the embryo sac and the extensive development of the nutritive jacket. X 125.
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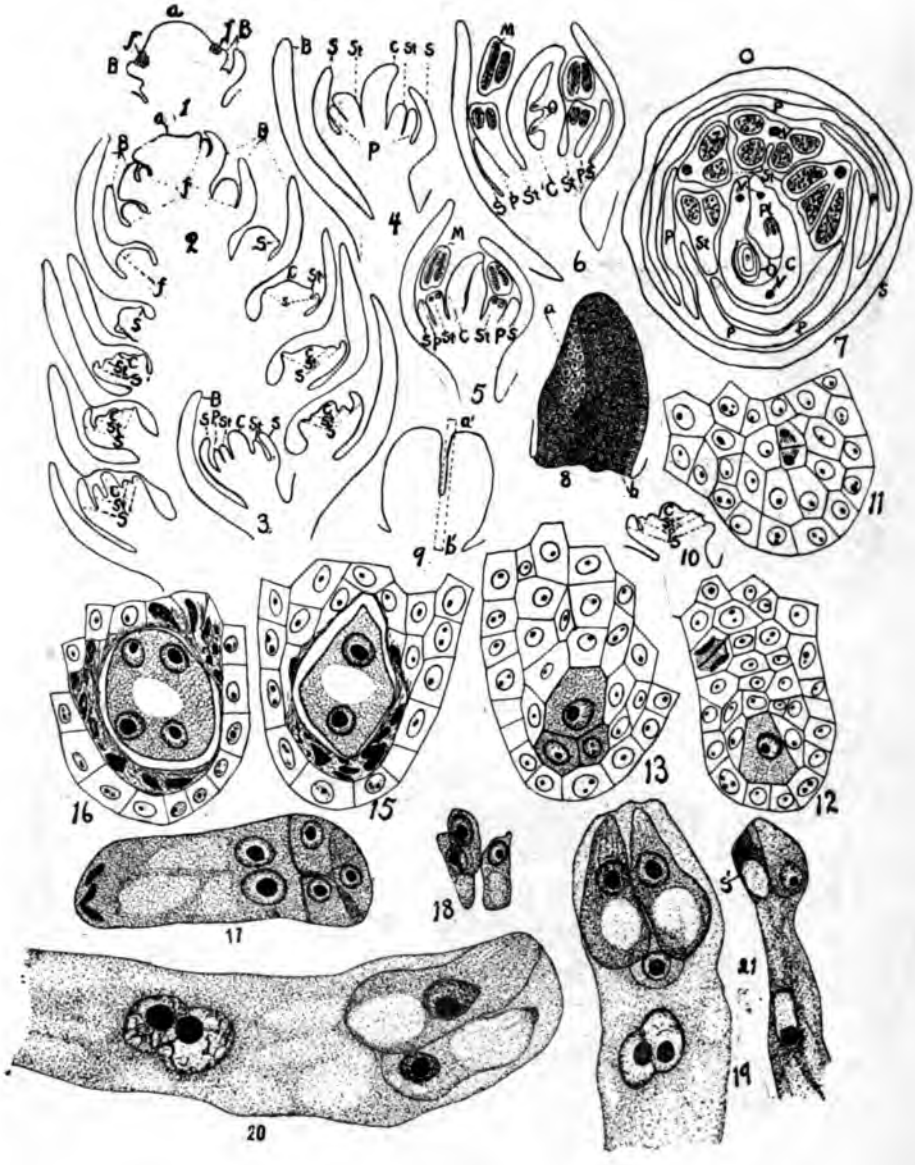
38. Nutritive jacket, same stage as Fig. 35. X 610.
39. Nutritive jacket, same stage as Fig. 36, micropylar region. X 610.
40. Nutritive jacket, same stage as Fig. 36, chalazal region. X 610.
41. Mass of endosperm serving as an haustorium in chalazal region of embryo sac. Same stage as Fig. 37. X 610.
42. Section in region of the funiculus in the plane of the mass of tracheid-like cells; (T) tracheid-like cells, (V) raphe, (c) columnar cells of seed coat. The section is in the plane indicated by the line a'b'; Fig. 43 X 345.
43. Same as Fig. 42 but slightly earlier and in a plane perpendicular to it as indicated by the line ab, (T) tracheid-like cells, (C) columnar cells of seed coat, (C') columnar cells of funiculus, (E) parenchyma of funiculus in path of food supply. X 610.

44-50. Distribution of starch in ovule. Amount of starch is indicated by the thickness of stippling.

44. At about the megaspore stage. 345.
45. At the time when the embryo sac begins to enlarge. X 345.
46. At the time of fertilization. X 125.
47. Soon after fertilization. X 125.
48. At a considerably later stage. X 125.
49. In embryo just before formation of cotyledons. X 75.
50. In ovule and embryo at a much later stage; (C) columnar cells of seed coat, (V) raphe, (T) tracheid-like cells, (P) reserve proteid. X 75.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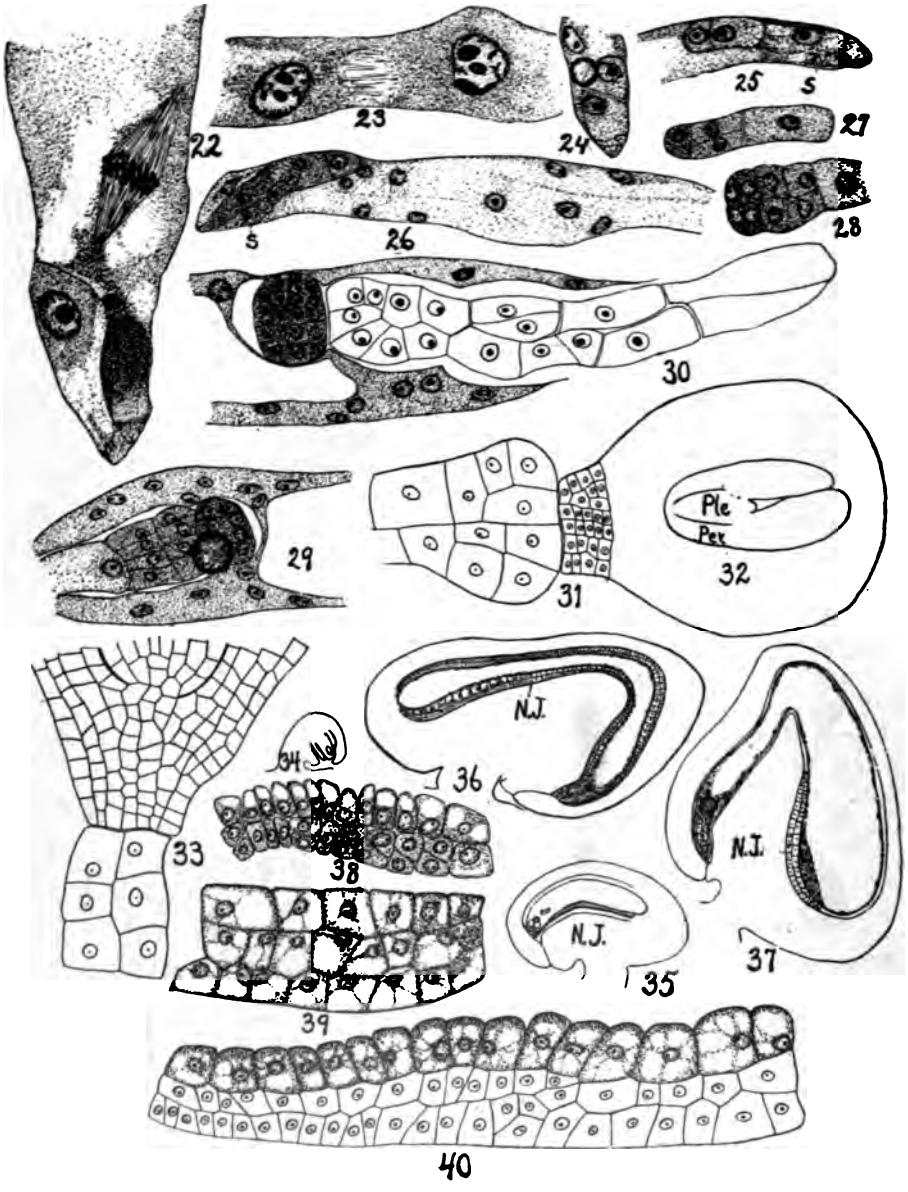
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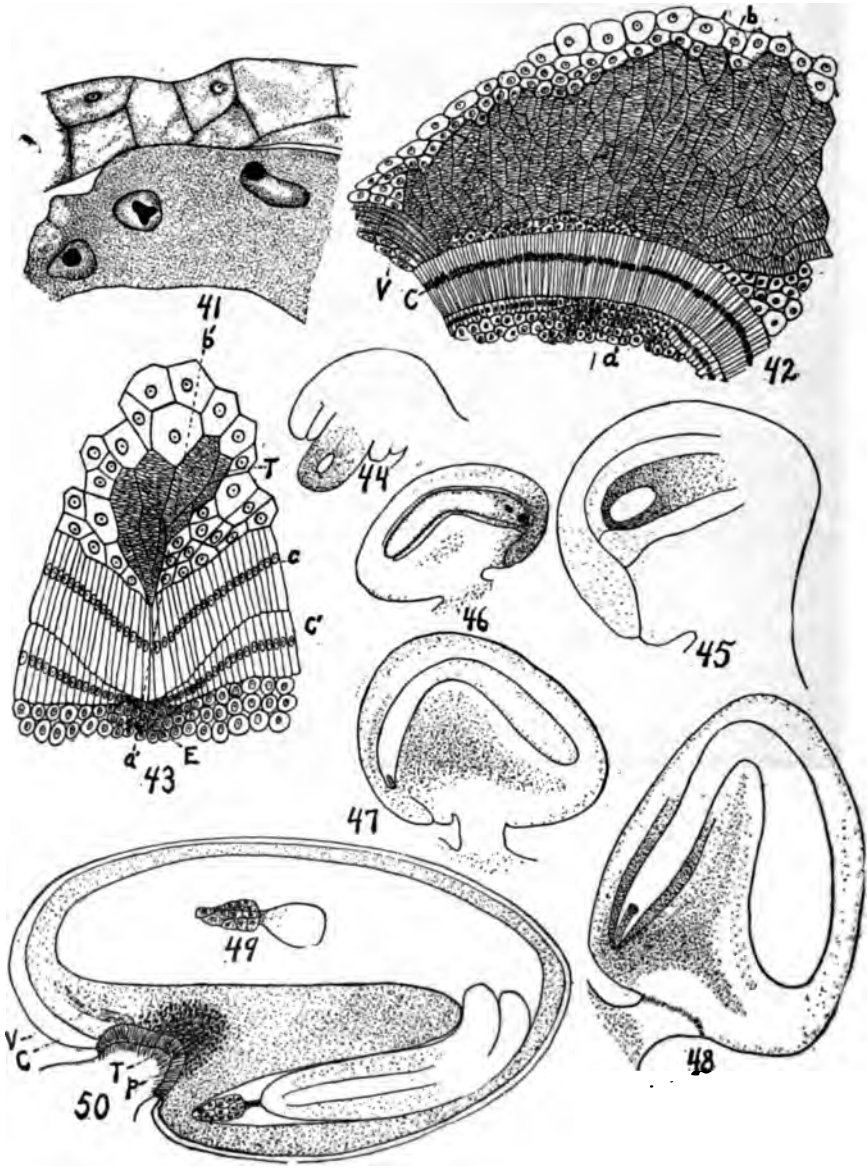
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Oxydase in Wheat Grains.

By Katherine Golden Bitting.

In many seeds the embryo is provided with a store of reserve food formed by the parent plant before the separation of the seed. In the dormant seeds the enzymes are usually in minute quantities as they are not needed, but when the food is needed during the germinative process, the enzymes are more strongly developed, the embryo dveloping itself, and also developing enzymes to provide food in suitable form.

A series of experiments were conducted to determine the enzymes present in dormant wheat seed, and its parts, and also in the germinated seed. The material for the experiments was obtained from a flour mill, and consisted of whole wheat flour, ordinary white flour, bran, shorts, and the unground grain.

Water extracts were made, 60 grams of flour being used with 100 cubic centimeters of distilled water, with the whole flour, and the white flour, 150 cubic centimeters of water with the shorts, and 240 cubic centimeters of water with the bran. The amount of water was varied in order to make them of as nearly as possible equal moisture, the shorts and the bran requiring more than the others. The mixtures were allowed to stand for 12 hours, and were then filtered. Powdered thymol was used to prevent decomposition. Glycerine extracts were also made, but were so much weaker in their action than the water extracts, that they were abandoned.

To determine the changes in enzymic action due to the germinative process, wheat was germinated for different periods, the grain being placed on moist paper under a bell jar, and kept at room temperature. At the end of the given period the grain was pounded in a mortar, then the enzymes were extracted for three days with water to which chloroform was added, after which the extracts were filtered. The periods of germination were three, five, six, and ten days respectively. Fifty grams of wheat grains were used in each case, and for the extraction 200 cubic centimeters of distilled water.

The extracts were slightly acid from the ungerminated grain, as shown by litmus, and more strongly acid from the germinated grains.

In obtaining the extracts from the various parts of the grain, the resulting liquids showed differences in color. The extract from the white flour was colorless, while that from the whole wheat was a straw color, that from the bran was slightly darker, and from the shorts darker still, so that one could recognize the extracts from their colors. The extracts from the germinated wheat grain were a pronounced brown color, the colors varying in depth with the time of germination up to six days, the six days being the darkest, beyond that no differences were appreciable. This was uniform in all the extracts made, so that like the extracts from the parts of the grain, the extracts from the germinated grains could be separated from one another by the degree of discoloration. Then again, sections of the wheat seeds, of the water lily petiole, and of the castor bean stem showed similar degrees of discoloration when placed in the solutions.

To test the oxidation, 5 cubic centimeters of each of the extracts from the different parts of the grain were taken and a few drops of guaiac tincture added, after which they were allowed to stand for some hours. In all there was a blue discoloration, but varying in degree. The white flour extracts showed a faint blue color, the whole wheat extract had a deeper tint of blue, while the bran and shorts extracts showed a decided blue color.

In testing the extracts from the germinated grain, 25 cubic centimeters of each were taken and precipitated with 85 cubic centimeters of 96 per cent. alcohol, then allowed to stand 36 hours, after which the precipitate was filtered off. The precipitate was dried on the filter at 35 degrees C., then redissolved in 25 cubic centimeters of distilled water. These solutions were then tested with the guaiac tincture, and all gave a decided blue color throughout the whole liquid.

The solutions were then tested with hydroquinone and pyrocatechin, polyphenols which are readily oxidized. At the same time for control purposes, equal quantities of the solutions but without the addition of the phenols, and also equal quantities of distilled water plus the phenols, respectively, were kept under similar conditions. The results are shown in the following table:

Extract.	Phenol.	Time.	Color.
Ungerminated.....	Hydroquinon	12 hours.....	Light reddish brown.
Germinated 3 days	Hydroquinon	12 hours.....	Reddish brown.
Germinated 6 days	Hydroquinon	12 hours.....	Deep reddish brown.
Ungerminated.....	Pyrocatechin	12 hours.....	Reddish brown.
Germinated 3 days	Pyrocatechin	12 hours.....	Deep reddish brown.
Germinated 6 days	Pyrocatechin	12 hours.....	Deeper reddish brown.
Ungerminated.....	....	12 hours.....	Pale straw.
Germinated 3 days	.....	12 hours.....	Deeper shade.
Germinated 6 days	.....	12 hours.....	Still deeper shade.
Dissolved in water	Hydroquinon	12 hours.....	Colorless.
Dissolved in water	Pyrocatechin	12 hours.....	Colorless.

The discoloration became apparent in the solutions with pyrocatechin in about 15 minutes, while the same extent of discoloration was not apparent in the solutions with hydroquinon for an hour. The table gives the results at the end of twelve hours, but the solutions were kept for a week. The longer they stood, the darker they became, the hydroquinon being of a wine red color, while the pyrocatechin solutions were of a brown color. At the end of four days, the six days extract with pyrocatechin was almost black. The experiments were carried on at room temperature. The solutions remained clear, no precipitates forming.

Temperature Tests.

To determine the temperature at which the enzyme was destroyed, the three extracts were heated to 60 degrees C. The tubes containing the extracts were placed in the steam sterilizer, a corresponding amount of water being placed in another tube in which was placed a thermometer. The extracts were kept in the sterilizer for one minute after the thermometer registered 60 degrees C.

Another set was tested but the temperature raised to 100 degrees C. Pyrocatechin was used with the enzyme, as, in the other tests, it gave a more rapid response than the hydroquinon.

60 Degrees C.—A slight darkening was apparent in twenty minutes. The longer they were kept, the darker they became, until at the end of four days they had a rich, deep brown color. They also showed the varia-

tions as to the ungerminated extracts being the lightest, the six days germination extract being the darkest, the three days germination extract being a shade between the two.

100 Degrees C.—These solutions were a little slower in responding, the discoloration not being apparent for 30 minutes, but showed similar discolorations to those extracts raised to only 60 degrees C. At the end of four days they were slightly lighter in shade than the corresponding extracts at 60 degrees C.

100 Degrees C.—To avoid any chance of error, the same quantities of the extracts were again taken, but heated over the direct flame of a Bunsen burner until the solutions boiled vigorously. They were then cooled rapidly in the snow, after which the pyrocatechin was added. At the same time two tubes of distilled water were boiled over the flame, and also had the pyrocatechin added, one being cooled before the addition, the other being quite warm.

The extracts plus the pyrocatechin behaved exactly the same as the extracts heated in the steam sterilizer. The solutions of distilled water plus the pyrocatechin remained clear and colorless.

100 Degrees C.—In the first set of experiments with the extracts from the various parts of the flour, the white flour extract gave the weakest color reaction, seeming to indicate either weakest or smallest quantity of enzyme. An equal quantity to that used in the other experiments was boiled over the direct flame for two minutes. Another quantity was taken but not boiled, both had pyrocatechin added to them. The boiling caused a white precipitate to form.

The discoloration was slow in appearing, it being fully three hours before there was a certainty in regard to it. Then it had a reddish appearance, like apple must when exposed to the air. In twenty-four hours there was a decided red color, but the boiled solution was slightly darker than the unboiled. The unboiled solution also formed a precipitate, both precipitates showing the coloration of the liquids. At the end of three days the color remained the peculiar red, but darker, the boiled one being considerably darker.

There was next tried some white flour extract and some six days germination extract, these two extracts being at the extremes of the discolorations, the former showing the lightest, the latter the darkest in the extracts, and in their action on the phenols. The extracts were placed in the autoclav, and kept until the indicator registered a pressure of ten

pounds, the temperature being 112 degrees C. It required thirty minutes to reach this pressure. The solutions were taken out as quickly as possible and cooled in the snow at once, after which pyrocatechin was added to each. The white flour extract had a white precipitate formed by the heat action, but this was an unpurified extract. The six days germination extract remained clear. A slight reddening appeared in the white flour, and a slight darkening in the other. (They were compared with extracts without the pyrocatechin.) This became more marked, the longer the extract stood. At the end of seven days the discoloration was quite marked.

The action of the oxydases is a very interesting and practical subject, as their action explains many puzzling phenomena, which were formerly classed as oxidations, but the cause and conditions of which were unknown. The composition of the oxydases is unknown, and consequently it is impossible to determine the number of oxydases—if there be numbers of them—except by the differences in reactions and conditions. From considering oxidation as a purely physiological process, as exemplified by respiration, and which only took place through vital processes, one has to consider oxidation from the opposite extreme.*

The most common manifestations of the action of oxydases are the discolorations of beets, carrots, apples, and many plant tissues and juices, besides the browning of wines and other liquids. The juice of the plant Rhus vernicifera from which lac varnish is made contains an oxydase which is, perhaps, the most widely known. Many of these have been investigated, and have been found to have certain points in common, though differing in others. They are all susceptible to the reaction of the medium, and also the temperatures at which they are rendered inactive vary within certain limits. The browning of wines is prevented by a temperature between 70 and 80 degrees C. or by Pasteurization at 60 to 62 degrees.† A large number of oxydizing enzymes which are found in different plants and animals are mentioned by Oppenheimer‡, the most resistive of which succumb to boiling temperature.

The enzyme which exists in the wheat grain, both in the quiescent and germinated grains, from the differences in degree of discoloration of extracts, and also action on phenols, exists in least amount in the white

*Pozzi-Escot, M. E. Les Diastases at Leures Applications, 1900.
†Lafar, F. Technical Mycology, p. 401, 1898.
‡Oppenheimer, C. Ferments and their Actions, 1901.

flour, and greatest amount in the shorts, that is, the endosperm has least, and the embryo most. This accounts for the discoloration of flour containing the embryo. The enzyme must be increased in amount or intensity during the process of germination, and up to six days germination, the extracts become darker, and the action on phenols also gives the same degrees of difference. The enzyme is more resistive to heat than those already noted. Bertrand and Bourquelot* say the oxydase extracted from Russula foetens Pers. is so resistive to heat that it has to be boiled some time before being destroyed.

Boutroux† has separated an oxydase from dough by soaking dough with twice its weight of water for half an hour, extracting by means of a press, then clearing by filtering through a Chamberlain filter. The extract was at first clear, then a precipitate formed, after which it turned brown, becoming black in the course of some weeks. His oxydase, however, lost its activity at 100 degrees C.

That the oxydase extracted by Boutroux is identical with the present one extracted from the various flours and grain is very probable. The difference in its resistance to heat may be due to a different kind of wheat, or to influences of environment.

Whether it be necessary to have a diastase present, as is claimed by Raciborski‡, it is impossible to determine, for the methods of separating the oxydases will also cause the separation of diastase and other ferments, and there is no known method of separating the majority of enzymes from one another.

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*Green, J. H. The Soluble Ferments and Fermentation, 1901.
†Boutroux, L. LePain et la Panification, 1897.
‡Raciborski. Ber. der deut. bot. Ges. XVI. 119, 1898.

Cytase in Wheat Grains.

By Katherine Golden Bitting.

The presence of cytase was tested on sections of the wheat grain, the petiole of the water lily, *Nymphæ odorata*, and the stem of the castor bean, *Ricinus communis*. The cells of the endosperm of the grain were so full of starch granules that the changes in the walls were difficult to see. In the other sections there is considerable collenchyma developed, which is very clear and distinct, and any changes in its structure are easily followed. The extracts from the ungerminated grain, and from three to six days germinations were the ones which gave the most satisfactory results.

The first tests were made using hollow chambers in slides, so that the changes might be followed under the microscope. These proved unsatisfactory as the section went to the bottom of the chamber and only the low powers could be used. Preparation dishes were then used, 5 cubic centimeters of the extract being used and chloroform for an antiseptic, with the sections immersed. A control was also kept, using distilled water instead of an extract. After three days the following changes were noted:

Water Lily Extract, ungerminated seeds—

Collenchyma. Thickened walls much swollen, middle lamella distinct, like a bright thread through thickening.

Parenchyma. Walls swollen, middle lamella distinct, intercellular spaces nearly obliterated.

Xylem. No change.

Water Lily Extract, three days germination—

Collenchyma. Thickened walls nearly fill cavity of cells, cavities showing as narrow canals.

Parenchyma. Walls swollen.

Xylem. No change.

Water Lily Extract, six days germination—

Collenchyma. Structureless mass, separate cells indistinguishable.

Parenchyma. Cells entirely separated, middle lamella gone.

The sections were so badly disorganized in this last that they could not be transferred to a slide. The observations were made on the remnants.

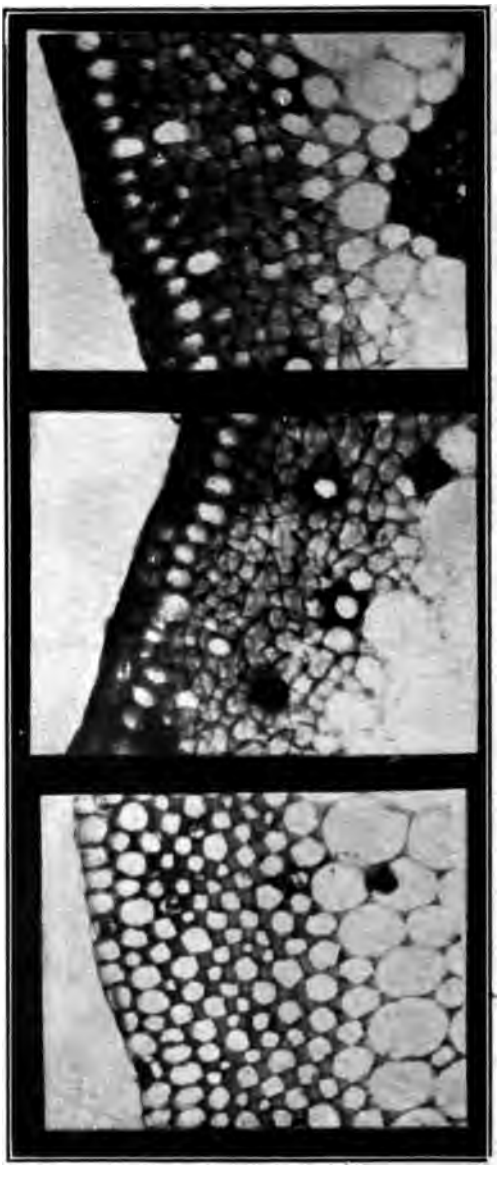
The castor bean is more resistive to the action of the cytase than is the water lily. The tissues of the castor bean showed practically the same effects as those of the water lily, but not quite so advanced.

The endosperm of the wheat sections was more susceptible to the action of the cytase than were the other sections. In the three days germination extract, parts of the endosperm had dropped out, so the sections could not be disturbed, while in the six days extract, only remnants were left adhering to the aleurone layer. The aleurone layer and the outer coats were unaffected. The middle lamella of the cells was attacked first, as was shown by the cells separating whole from one another.

Sections were tested in the extracts from the flours, but were acted on more slowly than those outlined, the white flour extract giving in nine days, results equal to those obtained from the ungerminated extract in three days.

The sections were made from alcoholic material, so that there was no protoplasmic action. Chloroform was used to prevent bacterial growth.

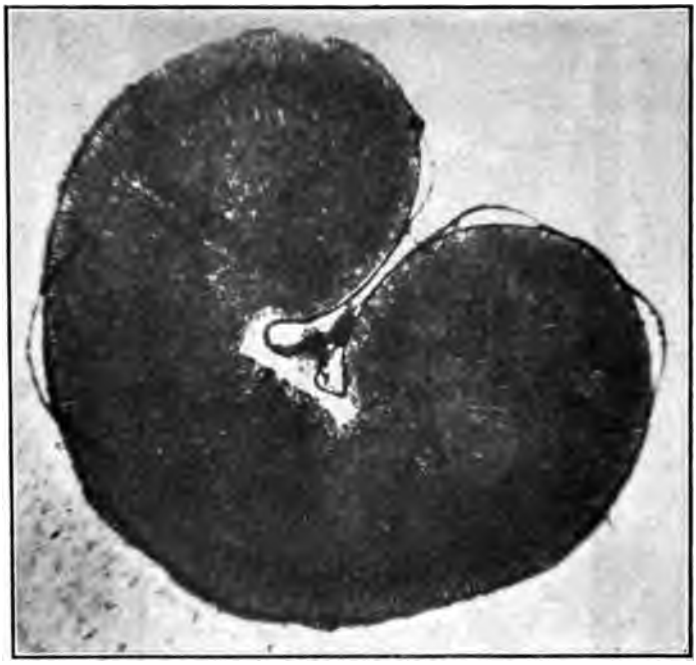
Seeds which had germinated for varying numbers of days were sectioned. In these, action was not so far advanced as in the sections placed in the extracts. For instance, seeds germinated for six days, when embedded in paraffin, and cut on the microtome, parts of the endosperm still remained as a granular mass.



Collenchyma treated with Cytase.

1. Normal.
2. Three days action.
3. Five days action.

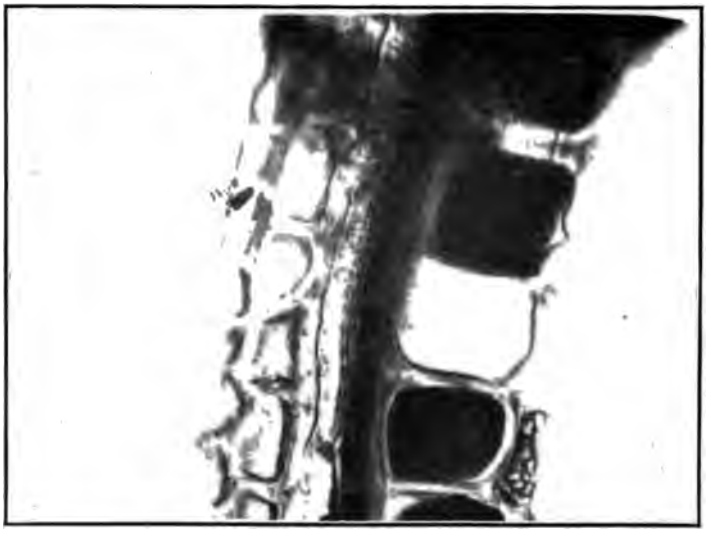
Sections of wheat grain treated with cytase.



1. Section before treatment.

2. Section after treatment.

3. Section before treatment, showing outer coats and aleurone layer.



4. Section after treatment, showing outer coats and aleurone layer.

Notes Upon Some Little-Known Members of the Indiana Flora.

(PAPER NUMBER THREE.)

By Charles Piper Smith.

Since offering my second paper under the above heading, my friend, Mr. Harley H. Bartlett, has been able to come to definite conclusion concerning certain of our Indiana collections not worked upon in time for inclusion in my last report. As before, his decisions are the result of careful study and comparison at the Gray Herbarium, where he has received the assistance of Mr. Fernald and Dr. Robinson whenever occasion demanded. Through the kindness of Dr. Schneck, Mr. Bartlett has had the pleasure of examining that gentleman's specimens of the genus Juncus, and I comply with my friend's request to note certain facts gleaned from his study of this interesting collection.

Specimens verifying these records are in the herbarium of Mr. Bartlett, except in the cases where it is specifically stated that no specimens were preserved.

Sorghum Halepense (L.) Willd. (Marion County.)

Occasional about Indianapolis. Included in the State Catalogue,* but no definite station noted. Taken August 20, 1904, by Mr. Bartlett.

Cyperus rivularis Kunth. (Marion County.)

Taken along Fall Creek, August 20, 1903, by Mr. Bartlett. In sandy soil; rare.

Carex pallescens L. (Madison County.)

A sedge so named by Mr. Bartlett was taken by me August 10, 1904, at a springy place by the File Works, Anderson. As this species is not recorded from Indiana, additional material is desired, since the material preserved is limited to the fruiting heads and perigynia in my seed collection.

Carex cephaloidea Dewey. (Tippecanoe County.)

Mature fruit of a sedge was obtained by me June 7, 1904, along the "Monon," just south of Lafayette. The characters of the whole plant were noted and later the material was referred to this species,

*Flowering Plants and Ferns of Indiana in State Geol. Report, 1899; 626.

by use of Britton and Brown's Flora. Specimens were not preserved, but the material placed in my seed collection has been worked upon by Mr. Bartlett, who reports that as far as can be determined from the fruiting heads and perigynia alone, my determination is correct. Only three or four tussocks of this sedge were noted, and the plant may owe its presence there to railroad introduction. The species has not been reported from the State.

Carex cephalophora Muhl. (Marion, Madison and Delaware Counties.)

Taken by me in these counties in 1904. Kosciusko and Vigo seem to be the only other counties from which this species is recorded.

Carex festucacea Willd. (Pulaski County.)

Mature fruit, etc., so determined by me was taken one mile south of Ripley post-office. Mr. Bartlett reports that this determination also seems to be correct. The sedge was abundant along ditches by the roadside, and ought to be common elsewhere in the State, although as yet unrecorded.

Juncus tenuis anthelatus Wiegand. (Posey County.)

Plants so determined by Mr. Bartlett were sent to him by Dr. Schneck, by whom they were collected June 7, 1881.

Juncus monostichus Bartlett.* (Madison County.)

This species was described from material collected by the writer August 6, 1904, south of Anderson. Using Britton and Brown's Flora, I could not identify the plant, but thought that it might be J. secundus Beauv. or J. dichotomus Ell. I turned the material over to Mr. Bartlett, who found it most nearly related to J. Greenei Oakes & Tuckerman, as shown by its seed characters. Since the original description was published, Mr. Bartlett has found that capsules of the type contain at least as many as thirty seeds, which means a greater productiveness than at first supposed. (C. P. Smith No. 140, in Herb. Bartlett and Gray Herb.)

Juncus dichotomus Ell. (Posey County.)

Of the Schneck Junci, the only Wabash Valley plant labeled J. dichotomus proved to be immature J. tenuis, so this species should be dropped from the State Catalogue (p. 675).

Juncus brachycarpus Engelm. (Wabash County, Ill.)

In Dr. Schneck's collection, from Mt. Carmel, Ill. Should be looked for on the Indiana side of the river.

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*Rhodora, 8: 50, 1904.

Nasturtium sessiliflorum Nutt. (Tippecanoe and Marion Counties.)

Reported in State Catalogue (p. 767) as "occurring only in the southwestern counties." I found it abundant over several acres of the Wabash bottom-land south of Lafayette, June 2, 1903. Mr. Dorner and I found also a few stray plants along the stream in "Happy Hollow," West Lafayette, later in the same month and year. The plants were all matured and through blooming at these dates. Mr. Bartlett took the species July 30, 1904, near Indianapolis, the flowering period being then about over.

Cardamine parviflora Pursh. (Clark County.)

Found on the "Knobs" of the State Forest Reservation, May 26, 1904. Plants on exposed knob-tops and slopes were simple or nearly so and from one to three inches high. In more shaded spots, lower down, were much-branched plants three to ten inches high. (C. P. Smith No. 118, in Herb. Bartlett.)

Cardamine flexuosa With. (Tippecanoe and Marion Counties.)

Not in the State Catalogue, but may have been reported at the last meeting of the Academy, of which the "Proceedings" have not yet reached me. Taken near Lafayette by Miss Gates, Mr. Dorner, and myself, in May 1903. Taken about the same time, near Indianapolis, by Mr. Bartlett. In looking through a collection made several years ago, near Indianapolis, Mr. Bartlett noted one sheet of this plant labeled "Sisymbrium officinale."

Agrimonia pumila Muhl. (Marion County.)

Taken by Mr. Bartlett August 14, 1904, near Indianapolis. This adds to my Clark County record of 1903.* Mr. Bartlett thinks that this so-called species is a mere depauperate form of A. microcarpa Wallr. I at first considered my Clark County plant to be a form of A. mollis (T. & G.) Britton, with which I found it growing.

Lupinus perennis occidentalis Wats. (Laporte County.)

This is the form about Michigan City. Taken June 18, 1904; determined by Mr. Bartlett, and verified by Dr. B. L. Robinson. The typical L. perennis L. was taken by me between Mishawaka and South Bend, June 17, 1904 (No. 126). The variety blooms a little later than the type. (C. P. Smith No. 130, in Herb. Bartlett.)

*Proc. Ind. Acad. Sci., 1903; 134.

Oxalis cymosa **Small. (Marion County.)**

This is the common "sour-grass" about Indianapolis. O. stricta L. is also present, but is rather rare.

Gaura parviflora **Dougl. (Marion County.)**

Just before leaving Indianapolis, September, 1904, I ran across what is believed to be this species along Harding Street between the Terre Haute divisions of the Big Four and the Vandalia Lines. The plant was abundant and conspicuous. It was in fruit and it took some search to get even a belated sprig with a few flowers; but such was obtained and referred to Britton and Brown's Flora, the identification seeming to be unquestionable. Specimens were not preserved, except the mature fruit which is now in my seed collection. This species is native from Nebraska and Oregon to Mexico, and belongs to the list of western plants brought eastward by the railroads. Its abundance at this place indicated that it would hold its own if not soon exterminated by building and street improvement.

Sanicula trifoliata **Bicknell. (Marion County.)**

Taken by Mr. Bartlett July 4, 1903. Reported from Indiana by Britton and Brown, but not included in the State Catalogue. Mr. Bartlett comments, "This plant grows on river bluffs and wooded hillsides, whereas S. Canadensis is generally found in wooded bottomland. The two species appear to intergrade somewhat with one another, but never, so far as observed, with S. Marylandica."

Apocynum cannabinum glaberrimum **DC. (Marion County.)**

Confined to gravel shores along White River. Taken August 24, 1903, by Mr. Bartlett.

Ruellia ciliosa **Pursh. (Madison County.)**

Specimens taken along White River, at Anderson, August 6, 1904, have all the leaves verticilleate in threes. Such variation from strictly opposite leaves is very rare in the Acanthaceae. (C. P. Smith No. 141, in Herb. Bartlett.)

Galium Claytoni **Michx. (Marion County.)**

Taken July 10, 1904, by Mr. Bartlett, near Indianapolis.

Vernonia Drummondii **Schuttlw. (Marion County.)**

Taken at Mallott Park, August 14, 1904, by Mr. Bartlett. This is a State record and eastward extension of range.

The Direction of Differentiation in a Regenerating Appendage.

By Charles Zeleny.

(Abstract.)

When an appendage possessing the power of regeneration is removed a proliferation of new cells takes place at the cut surface. At first the structures of the new appendage can not be recognized in this cell mass, but gradually the various parts appear. The problem presented for solution is the determination of the manner of this differentiation. Do all the parts of the new appendage appear simultaneously? If not, is the progression of the differentiation from the tip inward, from the base outward, or from the middle toward both ends? Or finally, is the method more complex than any one of these?

The antennule of the common brook sow-bug (Asellus) was chosen as a suitable object for the study of the problem because the structural differences in its various segments are unusually great. A study of the early stages of the regeneration shows that the first segmental partitions appear at the base. These are followed very soon by others at the tip, and from this time on the new segments appear near the middle of the organ. The region of new growth is then located in one of the middle segments. Differentiation therefore proceeds from both base and tip toward the middle of the appendage.

An examination of the growing antennule of young animals shows the same method of development.

The Regeneration of an Antenna-like Organ in Place of the Vestigial Eye of the Blind Crayfish.

By Charles Zeleny.

(Abstract.)

The right eye stalk was removed in nine specimens of the blind crayfish. A year after the operation three were alive. Two of these showed no regeneration, but the third had developed an antenna-like organ in place of the removed one. The new organ consists of a slender feeler-like process covered with hairs and has the appearance of a functional tactile organ. The terminal third is unsegmented but the basal two-thirds is divided into segments.

The result is of interest because it furnishes the only instance as far as I know of the development of an apparently functional organ in place of a removed non-functional one.

CAMPOSTOMA BREVIS.

BY J. D. HASEMAN.

July 29, 1904, a class from the Indiana University Biological Station took a trip to the Wabash River to a point three miles above Wabash, Indiana. On examining the material I found, among many specimens of Campostoma, that seven were different from the common species, anomalum.

Later, I took a similar specimen from Deed's Creek, which is a small tributary to Tippecanoe River, three miles north of Winona Lake.

Type; a specimen 7.5 cm. long to base of caudal. No. 1142 I. U., Wabash River.

Cotype; a specimen 9.25 cm. long to base of caudal. No. —— I. U., Wabash River.

Cotype; a specimen 8.1 cm. long to base of caudal. No. —— I. U., Wabash River.

Cotypes; 2 specimens 6.5 cm. long to base of caudal. No. —— I. U., Wabash River.

Cotype; a specimen 7.8 cm. long to base of caudal. No. —— I. U., Wabash River.

Cotype; a specimen 7 cm. long to base of caudal. No. —— I. U., Deed's Creek.

D. 8; A. 7; scales 7-53-6; 22 scales before the dorsal; lateral line complete (50 or 51 pores) equidistant from the dorsal and ventrals; depth equals the length of the head and is contained 4.25 times in length of body; eye 4-5 in head; a large anal papilla; a breast plate between ventrals; a dark band in middle of dorsal and a faint one in anal; the alimentary canal is about 2½ times the length of body.

The scales are more readily deciduous in anomalum than in the new species, and anomalum is a little darker and has a darker peritoneum than "brevis." The alimentary canal of the new species is not half as long as that of anomalum and almost twice the diameter.

COMPARISON OF BREVIS AND ANOMALUM.

	Campostoma brevis.	Campostoma anomalum.
Length of body to base of caudal	82 mm.	81.5 mm.
Length of head	19 mm.	19 mm.
Diameter of eye.....	4.5 mm.	4.5 mm.
Length of pectoral.....	14.5 mm.	16 mm.
Length of ventral.....	11.5 mm.	12 mm.
Length of anal.....	13 mm.	13 mm.
Length of dorsal.....	15.5 mm.	15.5 mm.
Length of snout.....	7 mm.	7 mm.
Rays in dorsal	8.	8.
Rays in anal.....	7.	7.
Scales along lateral line	56 scales and 52 pores. The 93 mm. specimen and all others have 53 scales.	53 scales and 51 pores.
Back of eye to origin of anal.....	47 mm.	47 mm.
Greatest depth of body	18 mm.	20 mm.
Diameter of alimentary canal	1.5 to 2 mm.	1 mm.
Length of alimentary canal	150 mm.	360 mm.*
Folds on or about alimentary canal ..	About 11 longitudinal folds.	About 20 circular folds.

*In a 72 mm. specimen I got the entire intestines in a continuous string, which was 530 mm. long.

The chief differences between this species and anomalum are the length, character and arrangement of the alimentary canal. It may be named brevis in allusion to its comparatively short alimentary tract. The intestines of anomalum are always dark and break quite easily, while those of the new species are white and not so fragile. The intestines of anomalum contain principally mud, while those of the new species contain practically no mud; they are also more solid and wrapped up in fatty tissue. The alimentary canal of anomalum wraps around the air bladder many times, while the alimentary canal of brevis does not go around the

air bladder more than one to two times; and the other folds are not spiral but longitudinal. The eyes are not quite as dark (in two fresh specimens I observed a reddish tinge in upper edge of the eye). Compared with anomalum, the tail of the new species is a little stouter and its mouth is a little larger and more terminal, and the abdomen is not so thick. It has no dark vertebral line; no distinct opercular spot; and the lateral line is more distinct and passes over and under the eyes. But as before stated, the main difference is in the alimentary canal.

Anomalum is certainly a mud-eater, while the diet of brevis is not altogether confined to mud; some had grassy substances in their alimentary canals. The difference is not a sexual difference. I examined several males and females of anomalum, and all of them had the peculiar arrangement of the alimentary canal of the typical anomalum. Number 8095 of Indiana University Museum is identical with the new species. It was taken in Tennessee by S. E. Meek, and was not examined internally.

Notes on Some New or Little-Known Members of the Indiana Flora.

By Guy West Wilson.

In preparing the present paper all notices of species of general and well known distribution in the State have been omitted and only those of more particular interest included. These plants naturally fall into three groups: first, those which have not previously been recorded as members of our flora; second, those which have been recognized as members of our flora since the publication of Dr. Coulter's Catalogue; third, those which are recognized in that catalogue, but known only from a limited region of the State or from a very few localities.

The nomenclature adopted is that of Britton's Manual. Synonyms are given only in case of species which bear a different name in Gray's Manual from that employed here, or which have been previously reported from the State under another name. The twenty-seven species which are recorded for the first time as members of the Indiana flora are marked with an asterisk (*).

1. *Lycopodium porophilum* Lloyd & Underwood. **Rock Club-moss.**

The only reference in any paper on the Indiana flora to this species is by Dr. Coulter in the Proceedings of the Academy for 1901 (p. 301), where the distinguishing characters of this species and its range are quoted from Britton's Manual with the following remark: "The familiarity of Dr. Underwood with the Pteridophytes of the State places this reference beyond question." There is a specimen of this species in the Herbarium of DePauw University, which was collected by Dr. MacDougal and originally labeled L. selago. The specimen was collected at Fern, Putnam County, where the plant grows sparingly on sandstone cliffs in company with L. lucidulum. This is the type locality of this species.

2. *Canadensis Marsh Taxus.* **American Yew.**

"Found only in Putnam County, associated with *Tsuga canadensis*," according to the State Catalogue (p. 618). A specimen in the herbarium of the Eli Lilly Company, collected by Walter H. Evans, extends its range to the southern part of Montgomery County.

3. *Echinodorus cordifolius* (L.) Griesb. Upright Bur-head.

"Reported only from the southern part of the State and probably not extending far northward, as the species is southern in its mass distribution." (State Catalogue, p. 624.) The only citation given is Vigo County. This species occurs in abundance in a wet river bottom in Tippecanoe County, where it was collected in midsummer.

*4. *Panicum capillare gattingeri* Nash.

Hamilton County, with the typical form. Probably of wider distribution in the State.

5. *Chaetochloa verticillata* (L.) Scribn. (Ixophorus v.) Fox-tail Grass.

In waste places about dwellings, Tippecanoe County. Previously reported only from Marion County. (State Catalogue, p. 630.)

6. *Aristida oligantha* Michx.

Common along the Monon Railroad in Putnam County, growing in sandy soil. "Found in the counties bordering on the Ohio and lower Wabash rivers." (State Catalogue, p. 633.) Probably a railroad migrant, but now well established.

*7. *Bromus purgans* L.

Putnam County, in thickets. In his elaboration of the Gramineae for Britton's Manual Nash has included this species with B. ciliatus, from which it is easily distinguished by having the flowering glumes pubescent throughout, remarking that "the form known as var. *purgans* * * * may be distinct." Later he has separated the two species in Small's Flora of the Southern States. Probably of general distribution in the State.

*8. *Bromus erectus* Huds. Upright Brome-grass.

Tippecanoe County. This is the determination by the Bureau of Plant Industry of a specimen sent by Mr. Fisher of the Experiment Station during the present season.

9. *Bromus tectorum* L. Downy Brome-grass.

Putnam County, common along railroads and in waste places. Previously reported from Lake, Madison and Tippecanoe counties. (Proc. Ind. Acad. Sci. 1900: 137; 1904: 301.)

*10. *Lolium temulentum* L. Darnel.

Tippecanoe County. Streets of Lafayette, apparently introduced with grass seeds.

11. *Hordeum pusilum* Nutt. **Little Barley.**

Putnam County, common in waste places about towns. Previously reported from Tippecanoe County by Dorner. (Proc. Ind. Acad. Sci. 1903: 118.)

12. *Cyperus rivularis* Kunth. **Shining Cyperus.**

Putnam County, along streams. Previously reported "only from the northern part of the State * * * Round Lake (Deam.)." (State Catalogue, p. 649.)

13. *Kyllinga pumila* Michx.

Putnam and Tippecanoe counties. Vigo County is the most northern locality from which this species is recorded in the State Catalogue. (p. 651.)

*14. *Scirpus cyperinus eriophorum* (Michx.) Britton.

Hamilton County, in swamps.

15. *Eriophorum polystachyon* L. **Tall Cotton-grass.**

"Occurring in very wet grounds in Putnam County, upon the authority of Dr. MacDougal. So far as has come to my knowledge, the only record for the State." (State Catalogue, p. 655.) The specimen in the herbarium of DePauw University which should verify this citation is *Scirpus cyperinus*. The species is to be retained as a member of our flora, however, as it has been collected in Lake County by E. J. Hill.

16. *Carex lupuliformis* Sartwell.

Hamilton County. Previously reported only from the lake region of northern Indiana. (State Catalogue, p. 658.)

17. *Carex retrorsa* Schwein.

Hamilton County. Previously reported only from the southwestern part of the State. (State Catalogue, p. 658.)

*18. *Carex typhinoides* Schwein. **Cat-tail Sedge.**

Hamilton and Tippecanoe counties in swamps. A beautiful sedge which has probably been confused with *C. squarrosa*, as the present species is not given in Gray's Manual. The material from the two localities shows quite a wide range in the size of the spikes, the latter being short enough to suggest a large head of *C. squarrosa*, while the former are long enough to suggest a small cat-tail flag.

*19. *Carex prasina* Wahl. **Drooping Sedge.**
Putnam County, in wet woods and along streams.

*20. *Carex amphibola* Steud. **Narrow-leaved Sedge.**
Hamilton and Putnam counties, in dry soil.

21. *Tradescantia brevicaulis* Raf. **Low Spiderwort.**
Putnam County, on the brow of dry hills. Previously reported from Tippecanoe County by Dorner. (Proc. Ind. Acad. Sci. 1903: 118.) These citations materially extend the range of this species, which is given by Britton as Illinois, Kentucky and Missouri.

*22. *Tradescantia reflexa* Raf. **Reflexed Spiderwort.**
Tippecanoe County, along the Wabash Railroad east of Lafayette, where it is well established. Probably a railroad migrant, as its mass distribution is western. This species is easily distinguished from its relatives by its bluish, glaucous vegetation.

23. *Juncus bufonius* L. **Toad Rush.**
Hamilton, Putnam and Tippecanoe counties, common in wet places along streets and highways. Previously reported only from the northern part of the State. (Proc. Ind. Acad. Sci. 1900: 138.)

*24. *Juncus dudleyi* Wiegand. **Dudley's Rush.**
Hamilton County, in wet places. With the habit of J. tenuis, from which it is readly distinguished by the yellowish, cartilaginous margins of its leaf sheaths, the latter species having whitish, membranous margins.

*25. *Juncus secundus* Beauv. **Second Rush.**
Putnam County, very rare in dry pastures. The mass distribution is east of the Allegheny Mountains, and its occurrence inland by no means frequent.

26. *Hemerocallis fulva* L. **Day Lily.**
Tippecanoe County, along small streams. No locality in the northern half of the State is given for this species in the State Catalogue. (p. 679.)

27. *Populus grandidentata* Michx. **Great-toothed Aspen.**
Clay, Hamilton and Putnam counties. The former citation is based on a specimen in the herbarium of DePauw University which was collected by Dr. MacDougal, while the other two are from personal collections. According to the State Catalogue (p. 701) this tree has been reported only from the lower Wabash Valley.

28. *Humulus lupulus* L. Hop.

This species is given in the State Catalogue as an escape from cultivation, which is doubtless true of some of the stations of this plant within the State. In other localities it is evidently a native. Among these is a region of very low bottom land near White River in Hamilton County, where wild hops of a good quality are by no means rare. Some of the older residents of the county say that in the days when the greater part of this region was still unsettled that annual trips were made to the swamps of this region for the purpose of gathering the family supply of hops. This region furnished the hop vines which are still growing at some of the older homesteads.

*29. *Humulus japonica* Sieb. & Zucc. Japanese Hop.

Tippecanoe County, about dumps in Lafayette, where it produces seeds freely.

30. *Asarum acuminatum* (Ashe) Bicknell.

Putnam County, with *A. canadensis* and of about equal abundance. First recorded as a member of our flora by Mr. Dorner, who collected it in Tippecanoe County. (Proc. Ind. Acad. Sci. 1903: 118.)

31. *Chenopodium murale* L. Nettle-leaved Goosefoot.

Hamilton County. This weed has been introduced into the country districts in the packing of grocery boxes. It is also quite common in waste places about towns. Previously reported from Tippecanoe County by Mr. Stewart. (Proc. Ind. Acad. Sci. 1901: 283.)

32. *Atriplex patula* L. Spreading Orachne.

Hamilton, Marion and Tippecanoe counties. In the first two counties this is a common weed along country roads while it is very common in waste places about Indianapolis and Lafayette. According to Britton's Manual this species is confined principally to the eastern states. Previously reported from Marion and Steuben counties. (Proc. Ind. Acad. Sci. 1904: 303.)

*33. *Atriplex hortense* L. Garden Orachne.

Hamilton County, growing in waste places about towns.

34. *Allonia nyctaginea* Michx. Wild Four-o-Clock.

Tippecanoe County. Well established along the Wabash Railroad both east and west of Lafayette. Previously reported from Hamilton,

Putnam and Marion counties. In all the localities which have come under my observation this is truly a railroad weed. (State Catalogue, p. 733, Proc. Ind. Acad. Sci. 1904: 223.)

35. *Fumaria officinalis* L. **Fumitory.**

Putnam County. Previously reported only from the eastern part of the State. (State Catalogue, p. 763.)

*36. *Lepidium campestre* (L.) R. Br. **Field Cress.**

Putnam County, roadsides.

37. *Sisymbrium altissimum* L. **Tumbling Mustard.**

Hamilton, Putnam and Tippecanoe counties. The first notice of this species in Indiana occurs in the Proceedings of the Academy for 1901 (p. 300) where it is reported by Dr. Hessler as "growing along the State Line Railroad east of Lake Cicott, Cass County," and by H. W. Clark from Marshall County. In the Proceedings for 1903 (p. 134) Mr. Smith reports that a single specimen was taken along the Monon Railroad near the State Fair Grounds at Indianapolis. These records point to a wide distribution over the State as a railroad weed. This is one of the most important migrants which has entered our State in recent years, as it is one of the worst weeds of the grain fields of the northwest. So important indeed is this weed that it has received considerable attention both in experiment station and government publications. The station in Tippecanoe County indicates that the species has probably been brought in with grain, as it is found along the switch by one of the elevators.

38. *Barbarea stricta* **Andrz.**

This species is admitted to the State Catalogue on the authority of Dr. MacDougal, who reported it from Putnam County, but on account of range probabilities "it is somewhat doubtfully included." (State Catalogue, p. 766.) This species is quite abundant along a small stream in the central part of Putnam County.

39. *Boripa sinuata* (Nutt.) A. S. Hitchcock.

This species is also admitted to the State Catalogue tentatively on the authority of a specimen collected in Putnam County by Dr. MacDougal. (State Catalogue, p. 766.) This species is well established at a single station on the Big Four Railroad west of Greencastle where it has been able to maintain itself for the past fifteen years.

40. *Cardamine pennsylvanica* Muhl. **Smooth Bitter Cress.**

Previously reported by C. C. Deam from Wells County. (Proc. Ind. Acad. Sci. 1900: 139.) This species is probably of general occurrence throughout the State, but has been confused with *C. hirsuta*, from which it differs in the entire absence of pubescence. The reference to the latter species from Hamilton and Putnam counties in the State Catalogue (p. 768) should be transferred to the species under consideration as all the material in the herbarium of DePauw University and in my own collection from these localities belongs here. I have been unable to find a single specimen of *C. hirsuta* in either county.

*41. *Coringia orientalis* (L.) Dumort. **Hare's Ear.** *Treacle Mustard*

Putnam and Tippecanoe counties, along the Monon Railroad.

*42. *Heuchera hirsuticaulis* (Wheelock) Rydb. **Hirsute Heuchera.**

Putnam County, in dry woods and thickets. This species is intermediate between *H. villosa* and *H. americana*, from the former of which it is easily distinguished by the shallow, rounded lobes of its leaves, and from the latter by its hirsute scape. Previously reported from Steuben County. (Proc. Ind. Acad. Sci. 1904: 220.)

43. *Ribes gracile* Michx. **Missouri Gooseberry.**

Hamilton and Marion counties. This species is by no means common in this portion of the State. Previously reported from Vigo, Tippecanoe and Kosciusko counties. (State Catalogue, p. 778.)

44. *Ribes rubrum* L. **Red Currant.**

Putnam County, sparingly escaped from cultivation.

45. *Fragaria americana* (Porter) Britton. **American Strawberry.**

Putnam County, in hilly woods. Previously reported from Wells County by Mr. Deam. (Proc. Ind. Acad. Sci. 1900: 140.)

*46. *Potentilla sulphurea* Lam. **Rough-fruited Cinquefoil.**

Putnam County, streets of Greencastle and adjoining pastures, apparently introduced in lawn grass seed and now well established in a limited area.

*47. *Rosa arkansana* Porter. **Arkansas Rose.**

Putnam County. This western rose is established at a number of points along the embankment of the Big Four Railroad east of Greencastle.

*48. *Pyrus communis* L. Scrub Pear.

Hamilton and Putnam counties, in red clay soil. Within the course of a few years abandoned fields in the hill counties are covered with a growth of blackberries, hickory and pears. Fruiting trees are not uncommon.

*49. *Amygdalis persica* L. Peach.

Putnam County. A number of bearing trees are to be found about the dumps and in the woods where seeds have been thrown.

50. *Baptisia tinctoria* (L.) R. Br. Wild Indigo.

Tippecanoe County. A single plant of this species was found late in the fall at the brow of a hill in company with *Andropogon* and *Lithospermum*. The only locality given in the State Catalogue is Steuben County. (p. 799.)

51. *Geranium pusilum* Burm. f. Small-flowered Cranes-bill.

In the Proceedings of the Academy for 1903 (p. 118) Mr. Dorner says: "In the summer of 1902, this was found growing among the grass on the Experiment Station grounds. This one collection, however, without any additional observations is hardly enough to admit it to the State flora." The station in question appears to be well established and spreading, exterminating the grass.

*52. *Oxalis corniculata* L. Yellow Procumbent Wood-sorrel.

Putnam County, along the Big Four Railroad west of Greencastle. Britton gives the range of this species as "in ballast about eastern seaports, and frequently growing on the ground in greenhouses * * * Recently found in Ontario." The plant is also found in the warm regions of both hemispheres.

53. *Hypericum maculatum* Walt. Spotted St. John's-wort

Hamilton County. Previously reported from Steuben and Marion counties. (State Catalogue, p. 839; Proc. Ind. Acad. Sci. 1903: 134.)

54. *Sarothra gentianoides* L. Pine-weed.

Fulton County. Material collected by Dr. Underwood is in the herbarium of DePauw University.

*55. *Viola palmata sororia* (Willd.) Pollard.

Putnam County, in rich woods.

*56. *Viola papilionacea domestica* (Bicknell) Pollard. Field Violet.
Putnam County, in cultivated fields. Not common.

57. *Passiflora lutea* L. Yellow Passion Flower.
Putnam County, on the embankment of the Big Four Railroad west of Greencastle. The most northern record for the State. (State Catalogue, p. 846.)

58. *Onagra biennis grandiflora* (Ait.) Lindl. (Oenothera b. g.)
Putnam County, along the Big Four Railroad. The only previous mention of this species in the State is found on page 179 of the Proceedings of the Academy for 1901, where it is recorded that "a patch, probably of recent introduction, of var. grandiflora was found in moist ground near Warsaw."

59. *Anogra albicaulus* (Pursh.) Britton. Prairie Evening Primrose.
Tippecanoe County. The State Catalogue (p. 852) classes this species as "an exceptional form occasionally occurring in the southern counties. Its northern limit in the State seems to be Hamilton County." This showy flower was collected at two stations in the vicinity of Lafayette the past summer. It was rather abundant in a meadow east of the city and several plants were found along the Belt Railroad about a mile distant.

60. *Circaea lutetiana* L. Enchanter's Nightshade.
The texts with one accord speak of the plants of this genus as white flowered. This, however, is inaccurate, as the present species shows a marked variation in this respect. While the flowers are typically white there are all the intermediate shades up to a bright pink. The first part of the flower to change its color is the outside of the sepals, then the entire sepal, and last of all the petals. Dr. Coulter tells me that he has seen this form rather frequently in this State and in New York during the past summer. I have collected the red flowered form in a single locality in Hamilton County.

61. *Anagallis arvensis* L. Poor Man's Weatherglass.
Putnam County. A specimen of this species collected in Putnam County by Miss Amelia Ellis is in the herbarium of DePauw University. The most northern record given in the State Catalogue is Monroe County. (P. 873.)

62. *Obolaria virginica* L. Pennywort.

Putnam County, on a wooded hillside. The most northern locality previously reported in the State is Vigo County. (State Catalogue, p. 879.)

63. *Gonobolus leavis* Michx. (Ampelinus alibidus (*Nutt*) *Britt.*; Enslenia a.) Climbing Milkweed,

Hamilton and Tippecanoe counties. "Confined to the southern counties, its northern record being Vigo County." (State Catalogue, p. 884.) Each of these stations is of interest, as they very materially extend the range of this species in the State. The Hamilton County locality was in an abandoned roadway which had in latter years become a fence row. The soil is red clay and the locality about a mile from the river. The plant maintained itself for a number of years and began to spread to the adjacent fields. It was at last eradicated by the landowner. The vine is abundant in the bottoms of the Wabash River near Lafayette, where it is a bad weed in cornfields. This species is probably of wider distribution in the State than the recorded localities would indicate, as it is very easily overlooked on account of the superficial resemblance of its leaves to those of *Ipomoea pandurata* with which it grows.

64. *Macrocalyx nyctalea* (L.) Kuntze.

Tippecanoe County. A clump of this plant was found near the bank of the Wabash River near Lafayette. Previously recorded only from Vigo and Knox counties. (State Catalogue, p. 893.)*

*65. *Stachys ambigua* (A. Gr.) Britton. (*S. hyssipifolius ambigua* Gray.)

Putnam and Tippecanoe counties, in swamps and along streams.

66. *Melissa oficinalis* L. Bee Balm.

Hamilton County.

*67. *Ruellia strepens micrantha* (Engelm. & Gray) Britton. (R. s. cleistantha *A. Gray.*)

Hamilton and Marion counties. This is the commonest form of this species in the central part of the State.

68. *Lonicera sempervirens* L. Honeysuckle.

Tippecanoe County, on dry hillsides. Not previously reported "north of Wayne County." (State Catalogue, p. 944.)

*Since found common about Lafayette. June, 1906.

69. *Tragopogon porrifolius* L. **Oyster Plant.**

Putnam County, in waste places about Greencastle. Previously reported from Wells County by Deam. (Proc. Ind. Acad. Sci. 1900: 142.)

*70. *Silphium terebinthinaceum pinnatifidum* (Ell.) A. Gr.

Hamilton County. The citation of the species (State Catalogue, p. 982), is incorrect, as the specimens have laciniate radical leaves.

71. *Helianthus petiolaris* Nutt.

Tippecanoe County, along the Big Four Railroad west of Lafayette. Previously reported from Lake County. (Proc. Ind. Acad. Sci. 1900: 141.)

72. *Synosma suaveolens* (L.) Raf.

Hamilton County. The material first collected of this species was defective, and so determined as *Coleosanthus grandiflorus* and reported to Dr. Coulter. Later collections of material made a correct determination possible. The latter species should, therefore, be stricken out of the doubtful list of Indiana plants. (State Catalogue, p. 608.)

73. *Centaurea cyanus* L. **Blue Bottle.**

Tippecanoe County, in cultivated ground and about dumps.

*74. *Centaurea solstitialis* L. **Yellow Star Thistle.**

Dearborn County. This plant was sent to the experiment station under date of October 16, 1905, by Lute Helm of Moores Hill, who reported it as a weed in alfalfa fields. It is an old world plant which is sparingly naturalized in the Southern States. It can be readily distinguished from *C. calcitrapa* by its yellow flowers. This species is not included in Britton's Manual.

LAFAYETTE, IND., November, 1905.

Rust of Hamilton and Marion Counties, Indiana.

By Guy West Wilson.

The present catalogue of *Uredinales* is based chiefly upon a collection of thirty-eight species made in the southern part of Hamilton and the northern part of Marion counties between the 3d of August and the 2d of September of the present season. The hosts number forty-four, of which *Aster paniculatus* and *Arena sativa* were the most prolific, the former harboring three and the latter two species. Previously but two species, *Gymnoconia interstitialis* and *Dicaeoma canaliculata*, had been collected in this region. The former did not reappear in this collection, thus making the total number of species to date thirty-nine. This, however, can be regarded merely as a preliminary catalogue, as the collecting season was too short and the time which could be devoted to the work too limited to make an exhaustive collection. A number of other species have been observed in previous years, but as no specimens were collected they are not included in the present list. Careful collecting in this region would probably double the number of species and would certainly greatly extend the list of hosts for those already collected, as the host plants of forty-five other Indiana rusts as well as some thirty-five additional hosts of those here enumerated occur in this region.

Of the species catalogued, twelve may be classed as injurious, as their hosts are cultivated plants. A few other species occur upon plants which are cultivated elsewhere, and in such localities would be properly classed as injurious, while in the present instance they might even be considered beneficial species. Among the injurious species first place belongs to the grain rusts *(Dicaeoma poculiforme* and *D. rhamni)*, which often seriously reduce the yield of small grains. Of scarcely less importance is the blackberry rust *(Gymnoconia interstitialis)*, which was disastrously abundant in this region a half dozen years ago. So great was its ravages that a considerable acreage of blackberries which were cultivated for market had to be removed. The rust was not seen this season and was not abundant last, so the fruitgrowers are again putting out blackberries.* The Carolina poplar, which is used as a shade tree in towns, is sometimes seriously

*Abundant on wild sps. of *Rubus* in May, 1906.

affected by a rust *(Melampsora medusæ)*. The clover rust *(Cacomurus trifolii)* was found sparingly on alsike clover and abundantly on red clover, causing some damage to the crop in places. The asparagus rust *(Dicæoma asparagi)*, so far as it was observed, occurs only upon wild plants, and as this vegetable is not cultivated extensively in the infested region it has little economic importance save as a menace to the occasional asparagus beds in the vicinity. The corn rust *(Dicæoma sorghi)* was very abundant this season, but is not credited with any serious damage.

The five remaining species are to be regarded as injurious or not according to the host which they infest. The most important of these is the bean rust *(Cacomurus phaseoli)*, which was collected on corn beans and seen abundantly on dwarf beans, which it damaged to a considerable extent. This rust also occurs abundantly on a wild bean *(Straphostyles helvola)* which is a serious pest in low river bottoms. The various wild sunflowers as well as the common species *(Helianthus annuus)* are often seriously affected by a rust *(Dicæoma helianthi)*. By the middle of August the plants of the common sunflower in some sections of Indianapolis were almost defoliated, and such leaves as did remain were rendered unsightly by this rust. Had only that multitude of sunflowers which abound in the river bottoms and about the dumps of the city been infected, this rust would deserve a place among the beneficial species. All the wild species of aster are used for ornament, especially in country gardens, hence the three aster rusts *(Coleosporium solidaginis, Dicæoma asteris* and *D. caracisasteris)* assume the role of injurious species. This is especially true of the last species, which often sadly disfigures its host.

A number of species occur upon weeds of greater or less importance and so are to be considered beneficial, inasmuch as they assist in keeping these pests in check. Of these the rust of the wild morning-glory *(Dicæoma convolvuli)* and of the bind weed *(Dicæoma polygoni-convolvuli)* are probably the most important, as their hosts are among the worst of the rust-bearing weeds of the region. The rust of the cocklebur and horse weed *(Dicæoma xanthii)* also deserves mention. The iron weed rust *(Coleosporium vernoniæ)* is common and often entirely covers the lower surface of the leaves of its host to the serious injury of the latter.

At the time this collection was made conditions favored the detailed study of the rust flora of a limited area, to wit, section 5, range 4 east,

township 17 north. This section has an area of about seven hundred acres and is bounded on three sides and crossed from north to south by public highways. The land is gently rolling with a sandy loam soil and a red clay subsoil. In the northwest quarter is what was once a lake but is now a flourishing cornfield, on the western border of which a few small bogs remain unditched. This region is drained by a ditch which is partly open, and which crosses the low black lands of the southeastern quarter of the section. Of the forty or fifty acres of timber land scarcely an acre can be said to be in a state of nature, while the greater portion of this area is closely pastured and part of it is in process of clearing. The present population is sixty-six and is entirely agricultural. The staple crops are corn, wheat, oats, timothy and clover. Some fruit and a few vegetables are grown for market, but usually for home consumption only. The ornamentals are those usually found about country homes. The farms are kept as free from weeds as in the average Indiana neighborhood. Such a region is scarcely an inviting collecting ground and would often be passed by as unworthy of attention, yet it yielded thirty-six species of rusts on forty-three hosts. These are marked with an asterisk (*) in the catalogue.

The nomenclature of host plants is that of Britton's Manual, while the rusts are named in accordance with the usually accepted nomenclature. Synonyms are given for hosts when they have a different name in Gray's Manual and for the rusts when the last published notice of these was under a different name from that used in this catalogue. Reference to previous publication in the Proceedings of the Academy are by year and page. A set of specimens of this collection has been deposited in the herbarium of Dr. Arthur, who has kindly verified all determinations.

Order UREDINIALES.

Family COLEOSPORIACEAE.

1. COLEOSPORIUM SOLIDAGINIS (*Schw.*) *Thuem.*
   - *On Aster ericoides L. Hamilton.
   - *On Aster paniculatus Lam. Hamilton.
   - *On Solidago canadensis L. Hamilton, Marion.

2 COLEOSPORIUM VERNONIÆ *B. and C.*
   - *On Vernonia fasiculatus Michx. Hamilton.

Family MELAMPSORACEAE.

3. PUCCINIASTRUM AGRIMONIAE (*DC.*) *Diet.*

*On Agrimonia mollis (T. & G.) Britt. (*A. parviflora* Ait.) **Hamilton.**

4. MELAMPSORA BIGELOWII *Thuem.* (*M. farniosa* (Pers.) Schrœt.)

On Salix cordata Muhl. Hamilton.

*On Salix fluviatilis Nutt. (*S. longifolia* Muhl.) **Hamilton, Marion.**

5. MELAMPSORA MEDUSAE *Thuem.*

*On Populus deltoides Marsh. (*P. monilifera* Muhl.) **Hamilton, Marion.**

Family PUCCINIACEAE.

6. GYMNOCONIA INTERSTITIALIS (*Schl.*) *Lagh.* (*Puccia interstitialis* Schl.) Tranzschel.)

*On all species of Rubus. Hamilton. 1894 : 157.

7. CAEOMURUS CALADII (*Schw.*) *Kuntze.*

On Arisaema dracontium (L.) Schott. Hamilton.

*On Arisaema triphyllum (L.) Torr. Hamilton.

8. CAEOMURUS EUPHORBIÆ (*Schw.*) *Kuntze.*

On Euphorbia dentata Michx. Hamilton, Marion.

*On Euphorbia humistrata Engelm. Hamilton.

*On Euphorbia maculata L. Hamilton.

*On Euphorbia nutans Lag. (*E. hypericifolia* Gr.) **Hamilton, Marion.**

9. CAEOMURUS HEDYSARI-PANICULATI (*Schw.*) *Arth.*

*On Meibomia sessilifolia (Torr.) Kuntze.? (*Desmodium s.*). **Hamilton.**

*On Meibomia viridiflora (L.) Kuntze. (*Desmodium v.*) **Hamilton, Marion.**

10. CAEOMURUS HOWEI (*Pk.*) *Kuntze.*

*On Asclepias syriaca L. (*A. cornuti* Dec.) **Hamilton, Marion.**

11. CAEOMURUS JUNCI (*Schw.*) *Kuntze.*

*On Juncus tenuis Willd. Hamilton, Marion.

12. CAEOMURUS PERIGYNIUS (*Halst.*) *Kuntze.*

*On Carex utriculata Boot. Hamilton.

13. CAEOMURUS PHASEOLI (*Pers.*) *Arth.*

*On Phaseolus vulgaris L. Hamilton.

On Strophostyles helvola (L.) Britt. (*Phaseolus diversifolius* **Pers.**) Marion.

14. CAEOMURUS POLYGONI (*Pers.*) *Kuntze.*
    *On Polygonum aviculare L. Hamilton.
15. CAEOMURUS TRIFOLII (*Hedw.*) *Gray*
    *On Trifolium hybridum L. Hamilton.
    *On Trifolium pratense L. Hamilton, Marion.
16. DICAEOMA ANGUSTATUM (*Pk.*) *Kuntze.*
    *On Scripus atrovirens Muhl. Hamilton.
17. DICAEOMA ASPARAGI (*DC.*) *Kuntze.*
    On Asparagus officinale L. Hamilton.
18. DICAEOMA ASTERIS (*Duby*) *Kuntze.*
    *On Aster paniculatus Lam. Hamilton.
19. DICAEOMA CANALICULATA (*Schw.*) *Kuntze.* (*Puccinia indusiata* D. & H.)
    *On Cyperus strigosus L. Hamilton. 1894 : 157.
20. DICAEOMA CARACIS-ASTERIS *Arth.*
    *On Aster paniculatus Lam. Hamilton.
21. DICAEOMA CARACIS-SOLIDAGINIS *Arth.*
    *On Carex conoidea Schkuhr. Hamilton.
22. DICAEOMA CIRCAEAE (*Pers.*) *Kuntze.*
    *On Circaea lutetiana L. Hamilton.
23. DICAEOMA CONVOLVULI (*Pers.*) *Kuntze.*
    On Convolvulus sepium L. Hamilton, Marion.
24. DICAEOMA DAYI (*Clint.*) *Kuntze.*
    *On Sterionema ciliatum (L.) Raf. Hamilton.
25. DICAEOMA EMACULATUM (*Schw.*) *Kuntze.*
    *On Panicum capillare L. Hamilton.
26. DICAEOMA HELIANTHI (*Schw.*) *Kuntze.*
    On Helianthus annuus L. Hamilton, Marion.
    On Helianthus tuberosus L. Marion.
    *On Helianthus sp. Hamilton.
27. DICAEOMA LATERIPES (*B. and R.*) *Kuntze.*
    On Ruellia stripens L. Hamilton.
28. DICAEOMA MENTHAE (*Pers.*) *Gray.*
    *On Agastache nepetioides (L.) Kuntze. (*Lophanthus n.*) Hamilton.
    *On Blephia hirsuta (Pursh.) Torr. Hamilton.
    On Mentha canadensis L. Hamilton.
    On Monarda fistulosa L. Hamilton.
29. DICAEOMA MUHLENBERGIAE (*A. & H.*) *Arth.*
    *On Muhlenbergia diffusa Schreb. Hamilton.

30. DICAEOMA POCULIFORME (*Jacq.*) *Kuntze.*

*On Agrostis alba L. Hamilton.

*On Avena sativa L. Hamilton.

*On Triticum vulgare L. Hamilton.

31. DICAEOMA PODOPHYLLI (*Schw.*) *Kuntze.*

*On Podophyllum peltatum L. Hamilton.

32. DICAEOMA POLOGONI-AMPHIBII (*Pers.*) *Arth.*

*On Polygonum emersum (Michx.) Britt. (*P. muhlenbergii* Wats.) Hamilton.

33. DICAEOMA POLYGONI-CONVOLVULI (*Hedw.*) *Arth.*

*On Polygonum convolvulus L. Hamilton, Marion.

34. DICAEOMA PUNCTATUM (*Str.*) *Arth.*

*On Galium concinctum T. & G. Hamilton.

*On Galium trifidum L. Hamilton.

On Galium tinctorium L. Hamilton.

35. DICAEOMA RHAMNI (*Gmel.*) *Kuntze.*

*On Avena sativa L. Hamilton.

36. DICAEOMA SORGHI (*Schw.*) *Kuntze.*

*On Zea mays L. Hamilton, Marion.

37. DICAEOMA TARAXACI (*Plowr.*) *Kuntze.*

*On Taraxacum taraxacum (L.) Karst. (*T. officinale* Weber.) Hamilton, Marion.

38. DICAEOMA XANTHII (*Schw.*) *Kuntze.*

*On Ambrosia trifida L. Hamilton.

On Xanthium canadense Mill. Hamilton, Marion.

39. GYMNOSPORANGIUM GLOBOSUM *Farl.*

*On Crataegus punctata Jacq. Hamilton.

LAFAYETTE, IND., November, 1905.

A Travertine Deposit in Tippecanoe County, Indiana.

By Guy West Wilson.

On the west bank of the Wabash River, near the Indiana Soldiers' Home, a steep bluff skirts the stream. A short distance below the "Tecumseh Trail" the slope has been greatly modified by the action of the seep water which trickles down the bank and makes a small marsh near the level of the river. This region of a few square rods extent is the lodging place of the leaves and twigs from the forest trees above, thus materially impeding the flow of the small amount of seep water, which is highly charged with carbonate of lime, causing it to make a deposit. As this mass has been undistrubed for a number of years a considerable amount of travertine has been formed. The surface, and consequently the more recent, portion of the mass is quite soft, crumbling easily in the hand, while the deeper and older portion is hard enough to resist a sharp blow with a small hammer.

An examination of fragments of this travertine shows that at the present time our own flora is being preserved in fossil form. The deposit of lime is rapid enough to preserve the leaves and twigs of neighboring trees and of the herbaceous plants of the immediate vicinity. The former are principally oaks and maples whose leaves can be recognized both by their form and by the arrangement of their principal veins. The latter are chiefly grasses and sedges, although fragments of a few other swamp plants also occur. In the more moist portions of the region a sterile moss grows in abundance and is quickly encrusted with lime, forming a large bulk of the travertine at this point, and resembling certain of the chain corals *(Halysitidae)*. Some of the moss noticed were growing at the tip while completely encrusted at the base.

A large area of this portion of the formation is covered by a luxuriant growth of one of the thalose liverworts, *Conocephalus conicus* Dumort. As the substratum upon which this plant grows is less compact than in other portions of the deposit its fossil remains, which are the most interesting of all those which were noticed, are not so perfect as might have been the

case had the plant grown on a firmer substratum. Those found were merely fragments of the tips of the thallus and were thin casts without the markings which are characteristic of the upper surface, and without the rhizoids of the under surface. There was, indeed, nothing to distinguish the casts from those which might have been formed by any member of the group, except the fact that they agreed in size and form with the unmixed colony of this species which grows immediately above them.

LAFAYETTE, IND., November, 1905.

Additions to Indiana Flora, No. 2.

By Chas. C. Deam.

The species herein listed have been identified by competent authority, and mostly by the Department of Agriculture, Washington, D. C.

Botrychium obliquum Muhl.

Wells County, September 13, 1896; Steuben County, August 21, 1904.

Dryopteris filix-mas (L.) Schott.

Wells County, July 20, 1902. This species was included in Coulter's list, but no locality was cited.

Dryopteris bootti (Tuckerm.) Underwood.

Wells County, July 23, 1905.

Panicum gattingeri Nash.

Franklin County, August 23, 1903.

Panicum philadelphicum Trin.

Steuben County, August 11, 1903.

Panicum minimum (Engelm.) St.

Steuben County, August 12, 1903.

Eatonia pubescens Scrib. and Mer.

Orange County, May 25, 1901.

Elymus robustum Scrib. and Sml.

Wells County, September 1, 1904; Franklin County, August 23, 1903.

Juncus dudleyi Wiegand.

Steuben County, June 16, 1903.

Juncoides campestris multiflora Celak.

Orange County, May 25, 1901.

Tradescantia reflexa Raf.

Steuben County, June 16, 1903.

Salix fragilis L.

Steuben County, August 13, 1903.

Salix fragilis X *alba* Wimmer.

Wells County, May 7, 1899.

Roripa sylvestris (L.) Bess.

Fountain County, June 5, 1905.

Sophia intermedia Rydb.

Lawrence County, May 26, 1901.

Cassia medsgeri Shafer.

Wells County, August 27, 1905.

Meibomia illinoensis (A. Gray) Kuntze.

Steuben County, August 11, 1903.

Ptelea mesochora Greene.

Noble County, August 9, 1905.

Viola crassula Greene.

Steuben County, May 28, 1905.

Lactuca virosa L.

Steuben County, August 12, 1903; Wells County, September 6, 1903; Allen County, August 22, 1904.

Lactuca spicata integrifolia (A. Gray) Britton.

Wells County, September 17, 1905; Blackford County, September 3, 1905.

Euthamia hirtella Greene.

Wells County, August 27, 1905; Steuben County, September 9, 1903; Kosciusko County, August 24, 1905; Blackford County, September 3, 1905.

Mariana Mariana (L.) Hill.

Wells County, July 10, 1905. This is a migrant, being found in a cultivated field.

Some Monstrosities in Trillium.*

By Frank Marion Andrews.

The genus Trillium occasionally shows interesting variations, not only in the form, but especially in the number of the parts of the foliar and floral parts. These changes in form and phyllody are especially conspicuous about this region in the species Trillium sessile and Trillium recurvatum. Of these some notable variations have been observed. Two specimens were found growing within a meter of one another, one being Trillium sessile and the other Trillium recurvatum. In both of these specimens no trace of the usual stamens or pistil were present. All parts of the flowers were completely transformed into floral leaves, which in Trillium recurvatum were considerably larger, with the exception of the central ones, than the usual parts of normal flowers growing near them. In Trillium recurvatum the number of these leaves in the flowers without reproductive organs was twenty-three (23) and in the Trillium sessile fourteen (14). No gradation from petals to stamens was observed in these specimens, such as is sometimes seen in the Nymphaceae. The number of sepals and floral leaves, the venation and other features were normal in both of the specimens above named.

A third interesting variation was seen in another specimen of the Trillium sessile in which the usual parts were present, but varied in number. To enumerate—there were four floral leaves, somewhat smaller than in normal specimens, three small sepals, four large partly greenish petals, three small stamens and four styles. This change in the size and especially the number of very close successive whorls of the foliar and floral leaves was all the more striking inasmuch as the individual members of the whorls were very uniform in number and size. This particular plant was considerably smaller than normal specimens.

Some other specimens of Trillium sessile and recurvatum showed a sepal and petal either partly, or in some instances wholly, grown together. In these cases the sepal half, which could be distinguished by its position, was much greener than the other or petal part, which was partly white.

*See also Bott. Gaz., vol. 16, pp. 163 and 231, and vol. 19, pp. 137 and 460.

Trillium erectum also deviated somewhat from the usual appearance, without a multiplication of parts but apparently merely a partial substitution. For example, one specimen had the usual floral leaves, three sepals, five petals, four stamens and two styles. In all other respects these plants were normal. Some flowers of the other species have shown a tendency to unite two or more of the parts. Some slight deviations in Trillium nivale have been observed in the way of a union of the floral parts.

It would be an interesting point to determine whether or not the plant arising from a rhizome showing such changes as here mentioned would appear afterward. Accordingly experiments of this nature are in progress.

A Natural Proof That the Root Tip Alone is Sensitive to the Gravitation Stimulus.

By Frank Marion Andrews.

Pfeffer* and Czapek* have demonstrated that it is the root tip only that is sensitive to the stimulus of gravitation. In order to accomplish this end they resorted to the following method. Glass tubes of such a diameter as would just fit over the end of the root tip were made by drawing out thick-walled glass tubes. The tubes thus obtained were bent into an L shape, had a total length of about three (3) mm., and weighed about thirty (30) milligrams. They were closed at one end and left open at the other; each limb of the L-shaped tube made in this way had a length of 1.5 mm. The inside diameter of the tube depended on the size of the root for which it was intended. It was necessary in all cases to have this glass tube fit the root loosely. It was connected to a piece of cork and the germinated seedling also fastened to the same cork in such a way that the root tip projected into the glass cap about to the bend. The whole being rotated in a klinostat for some hours the root, freed of the stimulus of gravity, grew into the above mentioned glass cap and finally assumed its L-shaped form. When removed from the klinostat and placed with the curved tip of the root vertical and the rest of the root horizontal no geotropic curvature took place, which shows that since the tip of the root was constrained from bending, the sensitiveness of geotropic stimulus must be located there, else it would have bent at a point outside the glass tube. I have accidentally found a natural proof of this admirable and conclusive discovery of Pfeffer and Czapek. In some germinating corn I observed one instance in which the root of the embryo had not freed itself in the usual way, but instead, the scutellum was broken about midway and carried down by the root on its tip as a mass of tissue. The outer coats were not broken, and these adhering about the scutellum on one side in the usual way made the mass so strong that the root could not grow out of it—at least it did not do so. This mass of tissue when removed weighed fifteen (15) milligrams. The root had turned and grown

*Jahr f. wiss. Bot., 1895, Bd. 27, p. 243, and 1900, Bd. 35, p. 313.

in this mass toward the back of the scutellum at a right angle a short distance from the tip; upon removing all the mass from the root tip, which could be done quite easily, this curving was plainly evident. The root was fixed in a moist atmosphere on a sheet of cork, with the curved part in a vertical position and the rest of the root in a horizontal position, but no geotropic curvature took place. During the time the root was kept in this position it grew almost as rapidly as the control specimens which were used to estimate the growth. While this accidental occurrence of a cap-like mass of tissue on the root-tip showed and verified the same effect on geotropic curvature, as was proved by using the glass caps, nevertheless it eliminated all the dangers of traumatic effects, to which the glass-cap method might render these parts liable in the absence of skillful manipulation, upon which experimentation is being conducted.

Plasmodesmen.

By Frank Marion Andrews.

It has been shown by W. Gardiner,[1] Strasburger,[3] Kohl,[2] and others that plasmodesmen are not confined to the pits in the cell walls but that they may also penetrate the cell walls themselves at other places. Excellent names for the plasmodesmen penetrating the cell wall in the places above mentioned have been chosen by Kohl.[4] Those which pass through the pit membrane he calls aggregated and these which pass through the unpitted membrane solitary. Strasburger[5] has recommended for all these protoplasmic connections the term plasmodesmen. It has also been shown that the plasmodesmen arise independently of cell division, for in the dermatogen of a phanerogam, in which only anticlinal and radial walls are formed these plasmodesmen are present in the walls between the dermatogen and the next inner layer of cells.

The plasmodesmen arise, according to Strasburger, secondarily in a very early stage in the formation of the membranes, before the beginning of their secondary thickening. Pfeffer[6] states—according to reports—that a subsequent formation of very thin plama connections is just as possible, as the larger fusion of protoplasts, which is made possible by dissolution of adequate parts of the cell wall.

I have investigated the occurrence of plasmodesmen to some extent in the endosperm of Phoenix dactylifera, and find both the solitary and aggregate forms present in large numbers.

Fig. 1 represents a cross-section of a cell of the endosperm of this plant before treating with any reagent. The pits are large and numerous and are generally somewhat enlarged where the ends come together with the corresponding ones of contiguous cells. The walls are rather thick and hard. Fig. 2 is a longitudinal section of the endosperm of Phoenix

[1]Gardiner W. Arbeiten des Botanischen Institutes in Wurzburg 1888, Bd. 3, p. 52.
[3]Strasburger Ueber Plasmaverbindungen pflanzlicher Zellen Jahr für wis. Bot. 1901, Band 36, p. 493.
[2]Kohl-Ber. d. Deutsch botan. Gesellsch. 1900, p. 364.
[4]Kohl-Ber. d. Deutsch botan. Gesellsch. 1900, p. 364.
[5]Strasburger-Ueber Plasmaverbindungen pflanzlicher Zellen Jahr für wis. Bot. 1901, Band 36, p. 503.
[6]Pfeffer-Pflanzenphysiologie zweite Auf. 1904, Bd. II, p. 219.

dactylifera in which the wall has been greatly swollen and the plasmodesmen stained to make them more plainly visible. In this case I treated the specimens according to Gardiner's method first by allowing them to lie for a while in iodine and potassium iodide and then adding chloriodide of

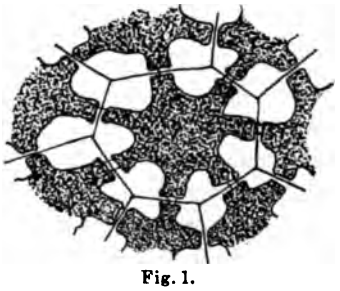

Fig. 1.

zinc and allowing it to act for twelve hours. The sections were then carefully washed in water. The walls were found to be strongly swollen to at least twenty-five times their original thickness where the pits occurred. In only a few instances were any of the aggregate plasmodesmen

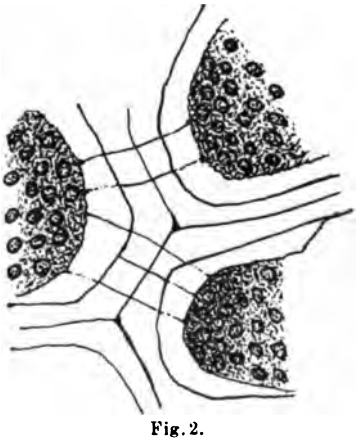

Fig. 2.

found broken where they entered the pit of the cell. Sometimes this occurred, especially in the solitary plasmodesmen, and a small filament could be seen as in Fig. 2. Attempts were made to bring these plasmodesmen more plainly to view by the use of Hoffman's blue, but this did not succeed very well. I found after considerable experimentation that

a solution of clove oil eosin stained them densely and then made them plainly visible. The solution I used was made by adding a small quantity of eosin to the pure clove oil. This stains very quickly and must therefore only be allowed to act a few seconds. The aggregate plasmodesmen did not show themselves in this specimen to be perfectly smooth threads of protoplasm but were coarsely granular or appeared considerably thickened at irregular intervals. (Fig. 2.) The solitary plasmodesmen, however, were more uniform. This appearance of the plasmodesmen was only to be seen to good advantage under very high magnification. The plasmodes-

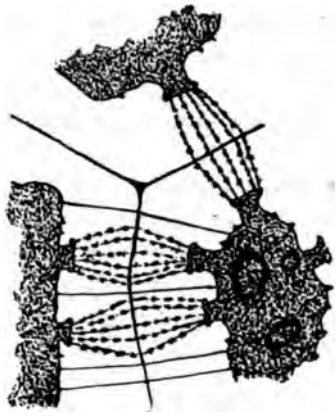

Fig. 3.

men shown in Fig. 2, for example, were magnified 2,250 times. The enlarged ends of the pits above referred to are better shown here than in Fig. 1.

The plasmodesmen in the cortex of Aesculus flava were also examined. To do this I removed the outer layers down to the green tissue, and the thin sections obtained there were treated in the same way as those of the endosperm of Phoenix dactylifera, except that instead of using chloriodide of zinc, sulphuric acid was employed for swelling. Clove oil eosin was also used here with good results. Hoffman's blue was also more effective than in the first case mentioned. The plasmodesmen of both kinds were made visible here, although the solitary ones were, as usual, more difficult to distinguish than the aggregate ones. Some experiments in demonstrating the plasmodesmen in moss leaves were also performed. This was done by plasmolysis. The leaves of Funaria hygrometrica, and often whole

plantlets as well, were placed in a 17 per cent. solution of cane sugar and left for a few minutes. This was sufficient to bring about a plasmolysis in all the cells and make the plasmodesmen evident when stained. This is shown in Fig. 3. The fine strands of protoplasm ran from the protoplasts to pits in the wall and from there through the wall to the opposite protoplasts. If the protoplasts were contracted too much by plasmolysis they were broken and the fragments could often be seen (Fig. 3).

When moss-cells were plasmolized in the way above mentioned they were fixed in a 1 per cent. solution of chromic-acetic acid, then washed in water and the walls swollen in the usual way.

The walls must be swollen considerably in Funaria hygrometrica to locate exactly the passage of the plasmodesmen. Although the protoplasmic fibers running from the contracted protoplasts were visible even directly after plasmolyzing they were made much more evident by staining with clove oil or Hoffman's blue.

The importance of plasmodesmen uniting the various protoplasts of a plant is evident in several ways. Experiments have been made to show[1] that stimuli may be transmitted through them. Even certain nutrient substances[2] may pass through them in mass or by diffusion, and Miehe[3] has even observed that nuclei may under certain conditions pass from one cell to another by means of the pores of the plasmodesmen.

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[1] Townsend, Jahr. f. wiss. Bot. 1897, Bd. 30, p. 484.
[2] Pfeffer, Pflanzenphysiologie zweite Auf. Bd. II, p. 225.
[3] Miehe, Flora, p. 115.

The Effect of Alkaloids and Other Vegetable Poisons on Protoplasm.

By Frank Marion Andrews.

It has not yet been satisfactorily determined whether the protoplasm of plants is affected by alkaloids and other vegetable poisons,* and accordingly I have begun an investigation of this subject. I was enabled to begin this work at the Marine Biological Station at Wood's Hole, Mass., during a part of the summer of 1905, through the courtesy of the Carnegie Institution of Washington, D. C., which kindly placed at my disposal one of the rooms which it controls at that place. Naturally only a beginning could be made in this work which I am pursuing further now, but the results thus far obtained are not without interest.

Many alkaloids are only slightly soluble in cold water, as for example, strychnine, of which only about one part in seven thousand (7,000) is soluble in water. The salts of the alkaloids are, however, much more soluble in cold water, both fresh and sea water.

My first experiments were carried out with strychnine sulphate on volvox. This was found in great abundance in a pond some distance from the station. When the volvox was put in a solution of strychnine sulphate containing .125 gr. in 875 cc. of fresh water the movement of the plant was at first accelerated, but it was killed by this solution in one hour. The color of the vegetative cells became lighter and when colonies were present these were a little darkened. I then placed a drop of water on the slide and to this I added some crystals of the strychnine sulphate. The volvox individuals at first swam to these dissolving crystals, but coming too near entered a place where the concentration was fatal in five minutes. When put in a solution containing .01 gr. of strychnine sulphate in 100 cc. of water volvox was killed in one hour and thirty minutes. When placed in a solution containing .01 gr. of strychnine sulphate in 1,000 cc. of water volvox was killed in one hour and forty-five minutes. At the expiration of twenty-four hours the volvox individuals were perfectly discolored and disorganized. Distilled water does not affect volvox outside of the effects of nutrition, if properly prepared.

* Pfeffer Pflanzenphysiologie zweite Auf. 1904, Bd. II, p. 333.

Other fresh-water forms such as Oscillaria, Chrococcus, Cosmarium, Closterium, Desmids and Diatoms were not killed in a solution of strychnine sulphate containing one gr. in 1,000,000 cc. of water. The movement of the protoplasm even did not stop. I have not yet determined the exact lethal concentration of strychnine sulphate for these forms.

Marine forms of the Cyanophyceae (as Oscillaria and Rivularia); also Diatomes; Chlorophyceae, as Cladophora and Enteromorpha; Brown Algae, as Ectocarpus; and Red sea weeds, as Polysiphonia and others were not killed in a solution of strychnine sulphate having one part in 100,000 of water. Nor was the movement of the protoplasm stopped by this concentration. A solution of the same having one part in 10,000 also had no effect.

A solution of the same having one part in 1,000 also had no effect. A solution of the same having one part in 250 killed all the plants in twenty-four hours, but the animals which happened to be present were killed in seven hours.

There are only a few animals that can bear transferring from salt to fresh water and vice versa. One of these is the form Artemia salina, which may bear such treatment, but in so doing it assumes a somewhat different size and shape. As a rule animals that are transferred from salt to fresh water or vice versa, show at first accelerated movements, but these become rapidly slower and slower, death ensuing in most instances in a few seconds.

All the marine forms experimented with were killed in two hours by a solution of strychnine sulphate containing .5 of a grain in 100 cc. of water.

The above mentioned marine forms were killed in a solution of cocaine containing .5 of a gram in 25 cc. of water, in two and one-fourth hours.

A Specimen of Kirtland's Warbler, Secured May 13, 1905.

By D. W. Dennis and Loren C. Petry.

This specimen was secured May 13, 1905, rather late in the afternoon, probably 5:30 p. m. The place was the northern end of a thicket on the farm of W. W. Kirkpatrick, about five miles east of New Paris, Ohio.

This part of the thicket is composed principally of second growth, with no trees more than 25 or 30 feet in height. The particular place where the specimen was secured is near the edge of the thicket within a few feet of an open field.

At no time while the bird was seen did it go more than from eight to ten feet from the ground. It flitted about the branches of the bushes in the usual manner of warblers, and after going over one, would fly directly to the next, and in a similar manner, go over it.

A teetering motion of the tail was constantly kept up, and was very noticeable. In fact, it was this that first attracted our attention. While moving about the branches, the tail was almost constantly moving up and down. This motion was not a motion of the body, as in the sandpipers, but of the tail alone.

The bird was not shy, and permitted us to approach within 20 or 25 feet, without flying or showing any alarm. At this distance it was easily possible to see the black spots upon the yellow underparts, without a glass.

The specimen taken was a female, and is preserved in the private collection of D. W. Dennis. Not more than 25 specimens of this bird have been seen; its biography is nearly a blank.

Nitrifying Bacteria.

By A. J. Bigney.

Everybody is searching for the wealth of the world. The scientist, however, is the one who usually makes the actual discoveries. He may not reap much of the result himself, but the world is richer and better for his having lived in it.

The past few years has seen much wealth added to Indiana through the labors of her scientific men. New sources of income will be found and new applications made as time passes on.

To the most casual observer it is certainly true that southern Indiana, in particular, has too much abandoned land. Waste fields are to be seen on every hand in many communities, and in some localities most of the land has been turned over to the free action of the elements and to the rabbits. As the population increases this land will be needed. The people are not much concerned now, because there is an abundance of land in the country. If their farms become too poor they will sell out and move into other localities or into other States. The time is coming when there will not be the inducements in other places, so the farmers will be compelled to earn a livelihood on the old farm. Even now it would be less expensive and much more satisfactory, especially to their good ladies, to remain on the old farm and transform their worn-out land into a veritable garden. The Germans are doing this very thing now on the hill lands about some of our rivers. This shows that it can be done when our people are willing to devote themselves to the task and not be too anxious to become rich too quickly and with as little labor as possible. When this waste land is put under a high state of cultivation, it will make the country more beautiful and will thus be an incentive to the agricultural classes. Who does not feel encouraged when travelers compliment a people on their beautiful country?

The Department of Agriculture of our Government is accomplishing wonders in developing new plans for work through their laboratories at Washington and in the experiment stations. The farmers are being stimulated to take an interest in scientific farming and the work is being

made more practical and more interesting and also more popular. When they see that no line of work really needs more knowledge and skill it will be a strong inducement to our young people to think of spending their time in developing our country along agricultural lines.

The great need that may be seen in many parts of southern Indiana is the formation of a proper vegetable mould. This means that there must be a greater amount of proteid substance in it. This further means that nitrogen is the element most needed and the one most difficult to secure. Since about four-fifths of the air is composed of nitrogen it would seem that we should not lack for this substance. This source of wealth had remained hidden for centuries. Not until recently did we learn of the part that the leguminous plants play in this problem. Now we know that this class of plants is the one that can make use of the nitrogen of the air for the manufacture of proteid substances of plants.

Fewer than ten years have elapsed since the noted German scientists Nobbe and Hiltner suggested that pure cultures of soil bacteria might be used to inoculate new soils. German experiments continued to be made, but they were quite unsatisfactory.

In 1901 the Department of Agriculture of the United States began investigations in its laboratory of plant physiology to find an artificial medium in which bacteria would grow and still preserve its power or even to intensify its qualities. Furthermore the bacteria must have the power to penetrate the roots of the plants, because it is impossible to fix nitrogen unless they are stimulated by the activities of the plant itself. The result of this investigation was a liquid culture. This culture is put up in three packages, Nos. 1, 2, and 3. No. 1 consists chiefly of sugar with a little potassium phosphate and magnesium sulphate. No. 2 consists of cotton laden with bacteria. No. 3 contains ammonium phosphate. No. 1 is dissolved in one gallon of water and the bacteria placed in it. This must be kept in a warm place, the temperature of which is between 70 and 80 degrees. At the end of twenty-four hours No. 3 is added and kept twenty-four hours more under similar conditions. The water by this time will be quite milky. Examination with the microscope reveals myriads of bacteria in active state.

The seed is now thoroughly moistened with the water and spread out to dry as quickly as possible. This liquid culture will retain its qualities for about forty-eight hours. The inoculated seed may be kept

however for several weeks, or even for months, before sowing and still retain all its power of growth.

It has been demonstrated that each legume has its own particular kind of bacteria, hence the Department of Agriculture always desires to know what seed is intended to be used.

These cultures were completed by the spring of 1904 and sent out to 12,000 farmers in every State in the Union and in many of the foreign countries including New Zealand, South Africa and Australia. This gave every variety of climate and soil for making the test and also all classes of farmers for trying the experiment, whether particularly adapted to such work or not. Of course all did not report the result, but the reports that were sent in showed an increase of 79 per cent. in the production. The rate of increase for the different legumes was as follows: Alfalfa, 73 per cent.; red clover, 92 per cent.; garden peas, 87 per cent.; common bean, 80 per cent.; cow pea, 85 per cent.; soy bean, 51 per cent.; hairy vetch, 75 per cent., and crimson clover, 88 per cent. This certainly indicates a remarkable result and plainly shows that there is something in this method of increasing the fertility of the soil.

My own experiments extend over only the past season. I ordered my supplies in November, 1904, and they were sent to me February 1, 1905. I inoculated four and one-fourth bushels of red clover seed with two supplies of bacteria. I sowed the seed on 25 acres of land, most of which was in wheat. For comparison I sowed a strip that was not inoculated. The sowing occurred between April 4 and 10. Anxiously I watched the growing seed. As soon as the nodules began to form I could notice more nodules on the inoculated plants than on the uninoculated ones. This increase has continued throughout the season. In comparing the stand of clover with neighboring fields it is plainly seen that it is better, the plants more vigorous and healthful.

My experiments have not been as successful as I anticipated, yet I feel that it has been very encouraging and that it can be of service to the farmers in southeast Indiana. Many farmers already in various parts of the country have succeeded in getting a stand of clover or alfalfa where it had previously been impossible to get it to grow.

It might also be stated in this connection that soil which has been growing clover becomes inoculated, and this soil can be sprinkled over another field and it will become inoculated. When the soil is once inocu-

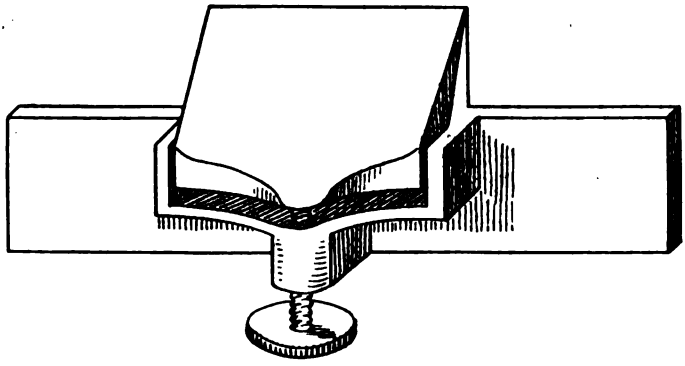
lated it remains rich in these germs and thus insures the perpetuity of the power of gathering nitrogen from the air. It may take a number of years to make the people see the advantage of this inoculation, but when it is shown that there is an actual increase in the production, the farmers will not be slow to take up with the method. I expect to continue my experiments, and already have supplies engaged for another season.

November 29, 1905.

A New Form of Microtome Knife.

By E. G. Martin.

The writer has been much impressed, both as student and teacher, with the great waste of energy and time involved in keeping microtome knives in satisfactory condition for use. In every biological laboratory the care of these knives is recognized as constituting a serious drain upon the student's time. In most undergraduate laboratories there is also apt to be more or less disposition to use poorly sharpened knives, rather than take the trouble to put them in satisfactory condition, with the inevitable



Microtome Knife.—In this drawing the two blades are shown clamped together in position for use, but without the cutting blade inserted. When the set-screw is loosened the front blade falls forward far enough to allow of the insertion of the cutting blade.

consequence of inferior sections. In order to insure that the student shall always be provided with a satisfactory cutting edge, and at the same time to avoid the expenditure of time necessary when the usual form of knife is used, the writer devised the instrument herein described for use in the biological laboratories of Purdue University.

The apparatus makes use of the patent safety razor blades which are now on the market at a moderate price. The form for which this instrument is adapted is the one which first appeared on the market. The

device consists essentially of a stout blade split lengthwise in a plane passing through the cutting edge, and having the two parts hinged together at the side away fram the cutting edge. By means of a setscrew the two parts of the blade may be firmly pressed together and held so. The thin blade, which is to be used as the actual cutting edge, is placed in position between the two parts of the supporting blade with its edge slightly projecting, and is firmly clamped there by tightening the setscrew. The instrument is then ready for use. For the details of structure the reader is referred to the accompanying drawing.

The device is adapted for microtomes, either of the Minot form or the Bausch & Lomb sliding form. In the author's hands it has cut as good sections with either instrument as he has ever gotten with the best knives of the old form. The capacity of the knife is limited by the shortness of the blade, but for practically all student work it will be found ample. The instrument possesses the great advantage that each student can provide his own cutting edge, the cost being trifling, and thus the confusion of having a number using the same knife is avoided.

The Present Status of the Chromosome Controversy.

By D. M. Mottier.

(Abstract.)

Cytologists are now agreed that the first mitosis in the spore mother-cells of higher plants is a "reducing" or qualitative division, the chromosomes being bivalent, and that the second mitosis is equational. Two views, however, are held concerning the manner in which the bivalent chromosomes are formed. Gregoire and his associates; Allen, and Strasburger and his students, maintain that the double chromatin thread appearing after synapsis is not the result of a longitudinal splitting of a single spirem, but the approximation of two spirems, one presumably paternal and the other maternal. On the other hand, Farmer and Moore and others, among whom is the writer, assert that the double spirem is due to a longitudinal splitting, which, as the spirem shortens and thickens, becomes indistinguishable except in certain cases. Parallel portions of the spirem, or a part of the same, now approximate, forming loops, the parallel sides of which are twisted upon each other. This looping or approximation of parallel portions of the spirem is accompanied by a second contraction resembling a partial synapsis. The result is that near the center of the nucleus there is formed a closely entangled or balled up mass of the spirem from which extend somewhat radially the loops or approximated parts of the spirem having a straighter course. Each parallel part of a loop is, for example, a chromosome, the two forming a bivalent chromosome. The spirem now segments transversely, and in case the parallel sides of the loops or the otherwise approximated parts of the spirem adhere at one end, as is very frequently true, the spirem may be said to segment into pieces equal to the length of two chromosomes. These two chromosomes, each of which is split lengthwise, now come to lie side by side, or to form rings, loops, X's, Y's, etc. (Lilium, Podophyllum.) The longitudinal splitting of the daughter segments observed during the meta, or anaphase, is, according to this view, the original longitudinal fission of the early prophase.

Assuming the individuality of the chromosomes, and that one-half is paternal and one-half maternal, Gregoire, Allen, Strasburger and others claim that the double spirem, developing in the prophase of the first mitosis, consists of the paternal and maternal spirems which have been brought together side by side during synapsis. But according to the view of Farmer and Moore and the writer, the double spirem is produced by a longitudinal splitting, and that it is composed of paternal and maternal chromosomes united end to end.

The Blooming of Cercis Canadensis in September.

By D. M. Mottier.

(Abstract.)

A small tree of Cercis Canadensis, or common red bud, growing on the campus of Indiana University was observed bearing many perfect blossoms upon three or four of its larger branches, September 20. The flowers were perfectly normal both as to structure and color. They remained on the tree for about the same length of time as in the spring. No fruits were formed however.

A Peculiar Monstrosity in the Seedling of Zea Mays.

By D. M. Mottier.

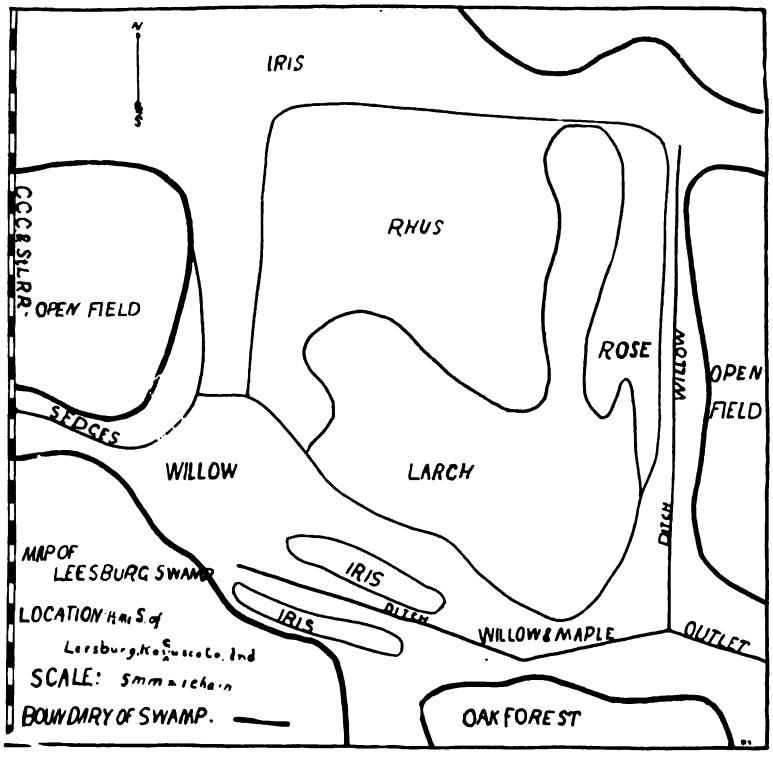
(Abstract.)

A seedling of Zea Mays was exhibited, which consisted of two perfectly developed shoots about eight centimeters long and two primary roots. Each primary root bore several secondary roots, and secondary roots had also put in an appearance at the lower nodes of each shoot. The double members arose just above and below the first node of the embryo, and apparently by the respective bifurcation of the shoot and primary root.

B. The Leesburg Swamp.*

By Will Scott.

Northern Indiana is dotted with lakes and swamps. This land surface is the result of the uneven deposits of the ice sheet and the modification of these by the processes of erosion, sedimentation and plant deposition.



Since the swamp illustrates so well the process through which present conditions came to exist, it was thought worth while to select a typical one, study its flora, physiography and plant depositions, and from these

*Trees of northern United States, by Apgar, was used for the identification of trees. Gray's Manual of Botany (sixth edition) was used for the identification of flowering plants other than trees.

Fig. 1. General view of the swamp (looking southeast). The open cultivated field is a portion of the bottom of the first lake which was exposed by the destruction of the first moraines. The foreground is a sort of bay to the present swamps and was a part of the second lake. The left center is the third lake area and may be distinguished by tamaracks and an intervening belt of Rhus.

things, if possible, determine former conditions and project those yet to be introduced.

The Leesburg swamp was selected. It is located in Kosciusko County, Indiana, one and one-fourth miles south of Leesburg on the east side of the C., C., C. & St. L. R. R. It has an area of 62 acres.

The work was carried on under the general direction of Dr. C. H. Eigenmann, director of the Indiana University Biological Station, and under the immediate direction of Dr. O. W. Caldwell. I wish also to acknowledge the assistance rendered by Mr. W. D. Curtis in collecting, and Mr. A. M. Mahaffey for most of the accompanying photographs.

Fig. 2. Sphagnum.

In this investigation Schimper's[1] division of ecological into climatic factors and edaphic factors was assumed and the edaphic factors only considered.

One of the main purposes has been to test the theories and factors proposed by Warming[2] and Cowles.[3]

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[1]Schimper, A. F. W.: Pflanzengeographie auf physiologischer. Grundlage, Jena 1898.

[2]Warming, E.: Plantsamfund. Copenhagen, 1895.

[3]Cowles, H. C.: The Physiographic Ecology of Chicago and Vicinity. Bot. Gaz., 1901.

Fig. 3. Cinnamon fern. (*Osmunda cinnamomea.*)

The theory of Warming is that all plant societies are determined primarily by the water content of the soil. Cowles accepts the proposition of Warming, but thinks it insufficient because of the fact that there is a wide variation in plant societies which grow in soils having the same water content. His most important conclusion is that plant societies are intimately associated with the physiography of a region and as the topographic forms change from one form to another the plant societies are also modified.

PHYSIOGRAPHY.

The evidence indicates that this swamp has been a lake or a part of a lake which at consecutive periods has occupied three distinct levels.

The First Lake.—A level plain whose elevation is about eight feet above the level of the swamp extends around the swamp and along its marshy outlet to the Tippecanoe River. Below the outlet two moraines approach the river from each side and show indications of being cut by water at their ends. It seems probable that these and possibly other moraines were continuous immediately after the glacial recession, while the Tippecanoe drainage basin was being established. This would have caused a large irregular area, including the area described, to be under water.

The Second Lake.—When these larger moraines were cut in two this lake was lowered to the level of a moraine, extending across its outlet and nearly parallel to the Tippecanoe River. The outline of this lake can be pretty accurately traced by the dark peaty soil and the sedges which still grow in what was the shallower part of it.

The Third Lake.—The erosion of the outlet tended to lower the water-level of the lake while constant deposition of plants that grew and died around the margin tended to bring the lake floor nearer the surface. These processes eventually resulted in limiting the lake to the much deeper "kettlehole" in the northern part of the area described. The kettlehole is the region occupied by the present swamp.

The outlet of this lake was not through a narrow moraine, as had been the outlet of the lake at higher levels, but through a channel one mile in length, whose slope was very slight.

By a series of excavations on the west side of the swamp it was determined that the slope of the sand under the peat for the first eighty-two feet, beginning at the peat margin was one in ten; that is, for every

Fig. 4. Cinnamon ferns with scale. Spaces = 1 foot.

Fig. 5. Pitcher plants (Sarracenia purpurea).

advance of ten feet toward the center of the swamp there was an increase of one foot in the depth of the peat. If this slope continues to the center, a depth of 117 feet would be attained. The evidence cited does not prove that the slope is so uniform nor that the depth mentioned did exist, but approximately such a depth is probable.

Here was a lake of considerable depth surrounded by a very level plain (the older lake bottom), with an outlet over a mile in length, and with shores of slight slope. What was the cause of its extinction?

Fig. 6. Drosera intermedia.

Description of the Swamp Proper (Fig. 1).—The drainage lines of the swamp begin at the northwest corner and extend around near the margins to the southeast corner. The central part is slightly elevated above the remainder.

These facts indicate that the plants are more vigorous in the center than near the margins. This elevated portion has in its center a U-shaped area of tamaracks (Larix Americana), with the open end of the U pointing northward. Most of this northern opening has been due to artificial disturbance. The primary drainage-lines are on the east and

Fig. 7. A lichen-covered tamarack.

south. On these sides the slopes are more abrupt. This has a very marked effect upon the flora.

The flora may be divided into four regions: (1) The tamarack area, (2) the west and north slope, (3) the south slope, (4) the east slope.

The tamarack area has many individual plants but few species. The tamaracks are very dense except in the southwest part. Mingled with these are poison sumachs (Rhus venenata), dwarf birch (Betula Americana) and huckleberry (Gaylussacia resinosa). The ground is covered with sphagnum, much of which is arranged in its characteristic hassocks. (Fig. 2.) Growing from among these hassocks and probably assisting in forming them are ferns (Osmunda cinnamomea), Figs. 3 and 4. Near the margin this fern is replaced by the Royal fern (O. regalis). Mingled with the sphagnum are pitcher plants (Sarracenia purpurea) (Fig. 5) and Drosera (Fig. 6). D. intermedia being the most abundant in the southern partion and D. rotundifolia in the northern part. As the dryer marginal regions are approached sphagnum is replaced by such mosses as Polytrichium, Leucobryum and Dicranum. In the slightly shaded portion two species of orchids were found (Calapogon pulchilla, and Cypripedium spectabile).

In the eastern part the boles of the tamaracks were covered with Parmelia, but in the southern and western part these were replaced with Cetraria aleurites and Usnea barbata of such vigorous growth that they often cover the branches to their tips and envelope the chlorophyl tissue (Fig. 7). Coincident with this is the death of the tamarack, but whether there is a cause and effect relation between these phenomena and, if such a relation exists, which is cause and which effect has not been determined.

Under this growth excavations showed that there was a great depth of pure peat. Many of the plants composing this peat were well preserved. It was possible to identify some of them as being of the same species as some of the living forms now growing above this accumulated debris.

The West Side.—At the south end of the west side, is a rail fence. Along this fence has crept in maples (Aces rubrum), poplars (Populus tremuloides), and a few elms (Ulmus Americana). This fence, as all artificial things seem to do, disturbed the natural sequence of plants. As a result of this disturbance, just north of it occurs a great variety of plant life, which, as one passes to the north, is differentiated into three well defined zones (Fig. 8). The inner is dominated by the poison sumach

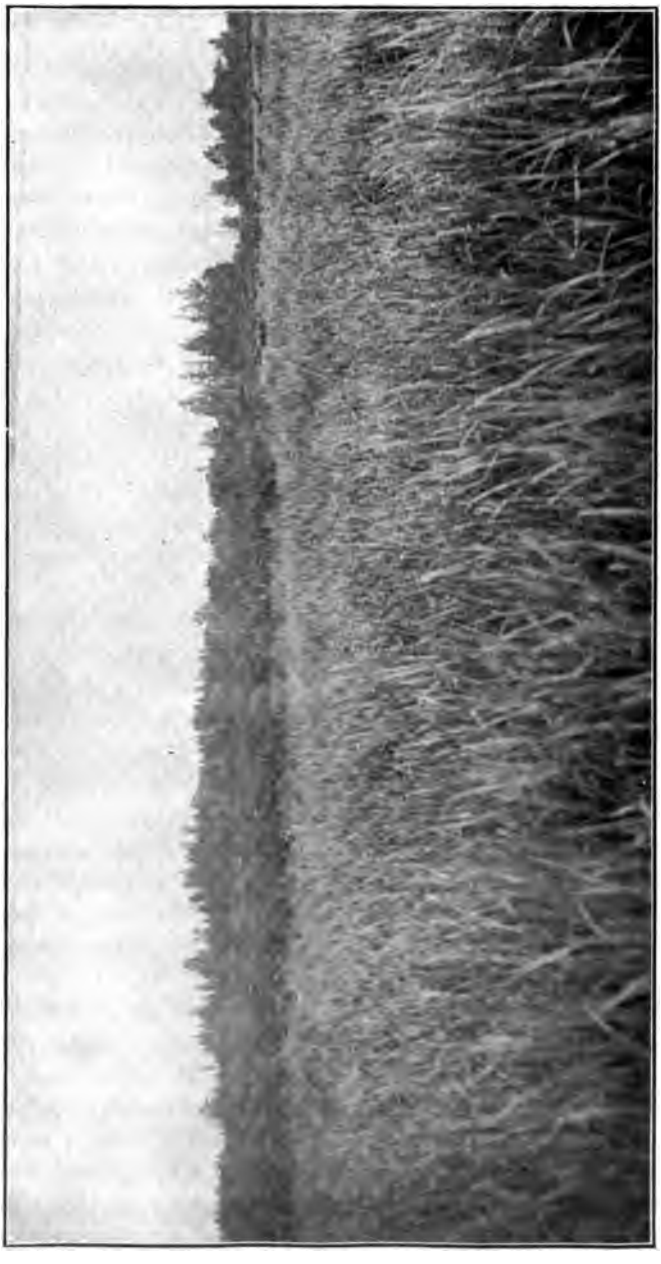

Fig. 8. The three zones on the west side.

(Rhus venenata), the second by blue flag (Iris versicolor) and the third by sedges. The Rhus belt contains a very little sphagnum, a few pitcher plants, and some droseras. These are plainly remnants of a condition similar to that which maintains at present in the tamarack area. Besides these there are sedges (Eriophorum Virginianum), swamp bellflower (Campanula aparionoides), and a few mints (Mentha Canadensis, and Lycopus sinuatus).

The Iris Zone.—The blue flag (Iris versicolor) gives the color to this zone, but there are nearly as many individuals of marsh shield fern (Asplenium thelypteris) and bonset (Eupatorium perfoliatum) as of Iris. These were the predominant plants, but there appeared a smaller number of goldenrods (Solidago Canadensis), meadow sweet (Spirea salicifolia), trow-weed (Vernonia Noveboracenous), horse-mint (Monardo fistulosa) agrimony (Agrimonia pariflora), and vervain (Verbena hastata). The mints and composites seem to be the most prominent among the forerunners of mesophytic life. Outside this was a fragment of a sedge belt. This contained coarse sedges and grasses (Scirpus atrovirens S. microcarpus, S. cyperinus, Panicum Crus-galli) and a few composites.

The north side (Fig. 9) is like the west except that there is no sedge zone, the Iris of the east end is replaced by calamus (Acorus calamus), and the Rhus almost disappears as the eastern extremity is approached. Two species, however, should be noted. On the inside of the Rhus zone two individuals of thistle (Cnicus lanceolatus) were found. These are, as it were, the extreme advance guards of xerophytic conditions. About the center of this zone, several individuals of Sagittaria (Sagittaria variabilis) in a healthy condition were found. So far as I am able to discover, this plant is never introduced except in water. This means that this plant has been able to survive the changing conditions from lake margin to Rhus belt by gradual adaptations. These plants were much smaller and contained less chlorophyl than plants of the same species growing in water at the same latitude.

The South Side.—The south side contains one of the primary drainage lines. Along this an open ditch has been dug. The willows (Salix nigra, S. alba, S. discolor, S. tristis, S. lucida, S. cordata) follow the ditch throughout its entire length. Near the east end the roses (Rosa Carolina) form a belt reaching from the deciduous forest trees on the south to the tamaracks on the north. North of the ditch they follow the ditch to its western extremity, but the zone becomes narrower. Toward the west a

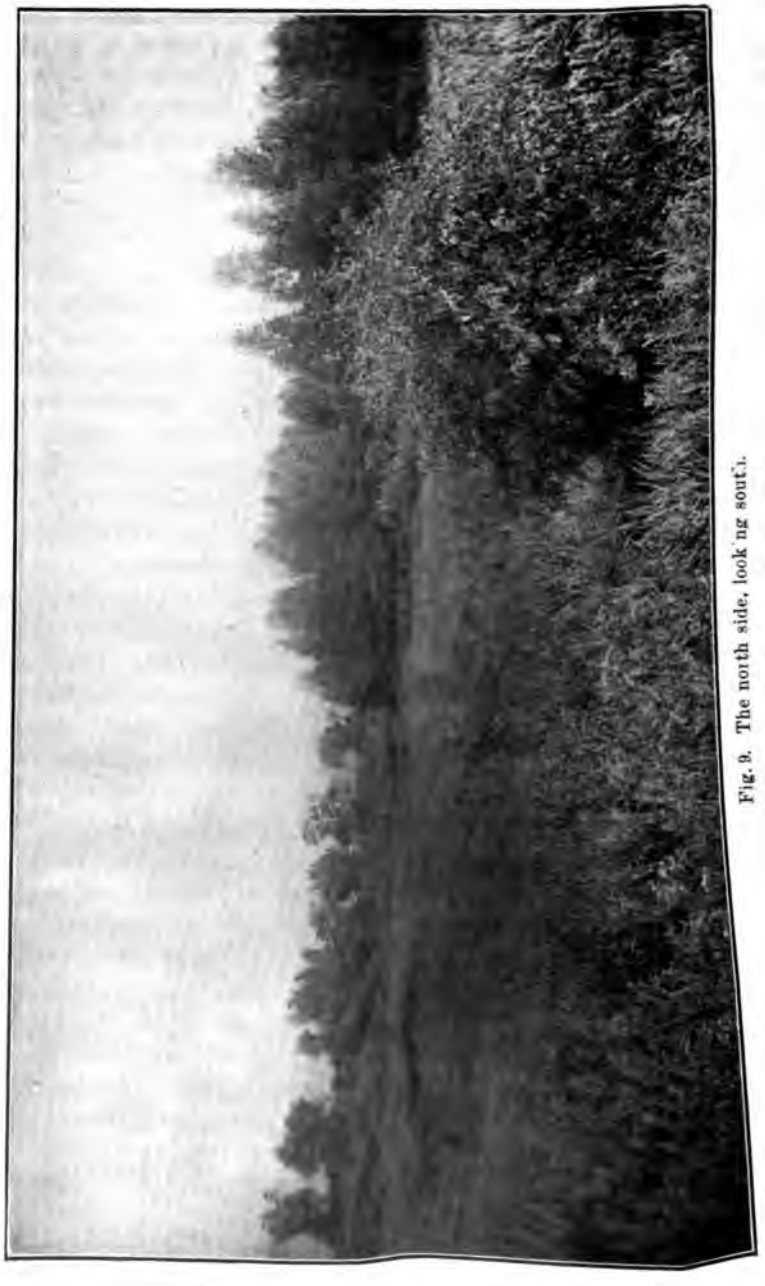

Fig. 9. The north side, looking south.

zone of Iris occurs on each side of the willows. Wherever Rosa occurs Spirea abounds. Spirea tomentosa on the east side and Spirea salicifolia on the south side. Along the damper parts of this area grow Polygonum sagittatum, P. parvifolium, P. hydropiperoides, Epilobum strictum, Plantago pusilla, Galium trifida, Panthorum sedoides, and Alisma plantago. There is a fine carpet of false purslane (Ludwigia palustris) over the entire area.

The ditch itself contains water only in times of flood. Notwithstanding this it is almost covered with floating forms of liverworts (Riccia finitans, Ricciocarpus natans). Yellow wated lilies (Nuphur advena) grow in it for more than half its length.

At the west end, there is a sort of bay that has recently been fairly well drained. This has resulted in the introduction of a great variety of species. Most of those found further east along this side persist. In addition occur: Eupatorium perfoliatum, purpureum, Helianthus annuus, Solidago Canadensis, Bidens chrysanthenroides, Pycnantheum lanceolatum, Mentha Canadensis, Lycopus sinuatus, Virginicus, Potentilla argentea, P. parviflora, and Verbena hastata. It is a fine example of confusion of species during a change of conditions.

The East Slope (Fig. 10).—On the east side there is a row of willows near the margin. Inside this there is a broad zone of roses (Rosa Carolina), in which is mingled poplars (Populus tremuloides), swamp oaks (Quercus tinctoria), and elms (Ulmus Americana).

General Remarks and Conclusions.

First.—On account of the great depth of the peat and the slope of the underlying sand we may conclude that this swamp was a lake which has been filled with vegetation, and that the process still continues.

Second.—That in recent years the growth has been most rapid in the center of the swamp, thus elevating it and forcing the drainage lines to the margins. This was made possible through the inhibition of the processes of decay so often noted in sphagnum swamps.

Third.—The fact, that there are no peaty remains on the level plain surrounding the present swamp, indicates that the first lake was a very ephemeral one. When a topographic form exists for a short time its effect upon the flora is so slight that an interruption may be caused in the usual succession of plant life. An excellent illustration of this fact has been observed in connection with these studies in the case of Little Eagle

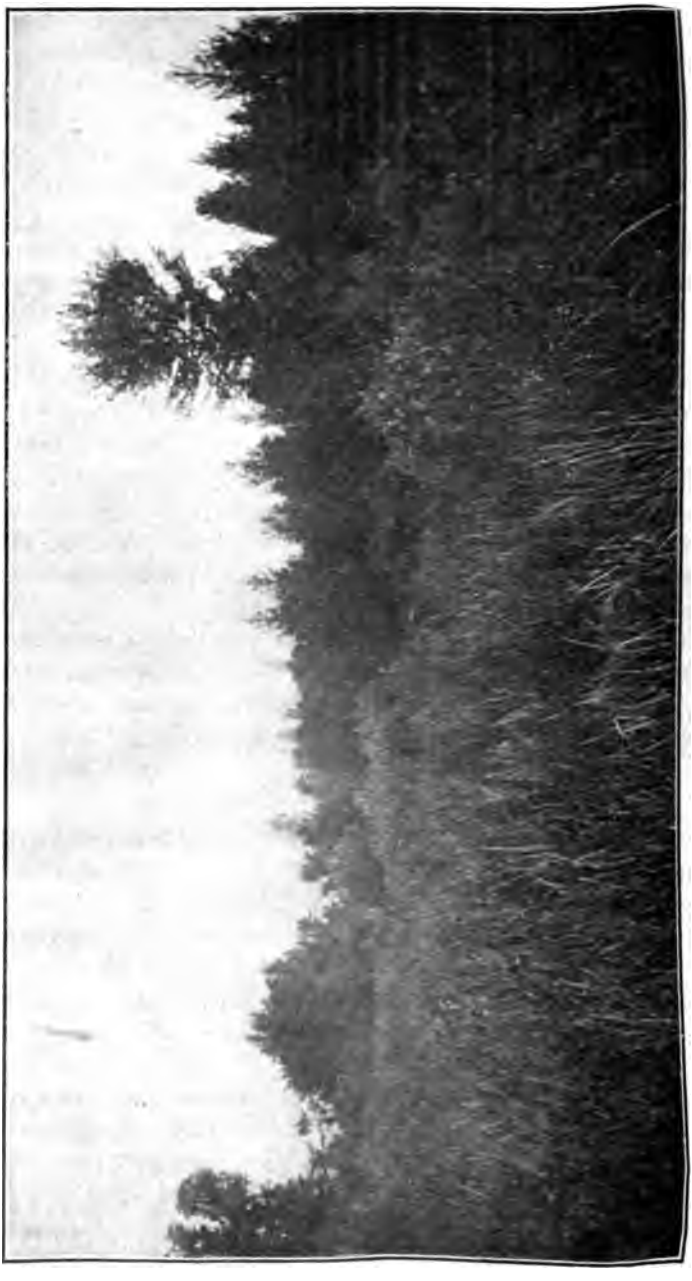

Fig. 10. The east side, looking south.

Lake, Kosciusko County, Indiana. Here the lake level has been lowered so rapidly that a meadow is developing without the usual intervening marginal swamp life.

Fourth.—Two additional comparative notes should be added. At the west end of Turkey Lake is a kettlehole which exhibits the early stages of the process. In parts the lake has been filled to the surface with plant remains. In some places the advance into deeper water is being made along the surface, so that a shelf of plant life exists with

Fig. 11. Kettlehole north of Eagle Lake.

very little beneath it except vegetable debris and water. The plant which contributes most to this is swamp loosestrife (Decodon verticillatus). It is soon assisted by sedges and willows, so that the zone which contains Decodon only is very narrow.

North of Eagle Lake is another kettlehole (Fig. 11), which exhibits the latter part of the process. The circular flat basin filled with peat and surrounded by moraines indicates clearly its origin. The water content of the soil would indicate mesophytic conditions. However the central part of this area is occupied by tamaracks. This affirms the proposition of Cowles that the change in topography may outstrip the co-ordinate modifications of plant societies.

Many more comparative studies will be required before each step in the process can be described in detail. All the conditions necessary for the formation of a tamarack swamp can not now be stated, although two are apparent (1) a relatively deep lake; (2) the destruction of this lake by plant deposition, for this alone can produce the proper substratum for the introduction of the tamarack.

A list of the orders of plants and the species in each found in the Leesburg Swamp:

1. NYMPHÆACEÆ.
   Nuphar advena.
2. SARRACENIACEÆ.
   Sarracenia purpurea.
3. GERANIACEÆ.
   Impatiens biflora.
4. ILICINEÆ.
   Ilex monticola.
5. SAPINDACEÆ.
   Acer rubrum.
6. ANACARDIACEÆ.
   Rhus venenata.
7. ROSACEÆ.
   Spirea salicifolia, S. tomentosa, Rosa Carolina, Potentilla Canadensis, P. argentea, Rubus hispidus, Agrimonia parviflora, Prunus Americana, Pyrus coronaria.
8. CRASSULACEÆ.
   Penthorum sedoides.
9. DROSERACEÆ.
   Drosera rotundifolia, D. intermedia.
10. ONAGRACEÆ.
    Epilobium strictum.
11. CORNACEÆ.
    Cornus Canadensis, C. florida, C. sericea, C. stolonifera, C. paniculata, Nyssa sylvatica.

12. CAPRIFOLIACEÆ.
Viburnum prunifolium, Sambucus Canadensis.

13. RUBIACEÆ.
Galium trifida, Cephalanthus occidentalis.

14. COMPOSITAE.
Vernonia noveboracensis, Helianthus annuus, Solidago Canadensis, Bidens chrysanthemoides, Eupatorium perfoliatum, E. purpureum, Cnicus lanceolatum.

15. LOBELIACEÆ.
Lobelia cardinalis.

16. CAMPANULACEÆ.
Campanula aparinoides.

17. ERICACEÆ.
Gaylussacia resinosa, Vaccinium macrocarpum.

18. VERBENACEÆ.
Verbena hastata.

19. LABIATÆ.
Scutellaria gulricdata, Monarda fistulosa, Pycnanthemum Virginiana, Mentha Canadensis, Lycopus Americana, L. virginicus.

20. PLANTAGINACEÆ.
Plantago elongata.

21. POLYGONACEÆ.
Polygonum sagittatum, P. hydropiperoides, P. arifolium

22. LAURACEÆ.
Sassafras officinale.

23. UTRICACEÆ.
Ulmus Americana.

24. JUGLANDACEÆ.
Carya alba, C. microcarpa

25. CULPULIFERÆ.
Quercus alba, Q. macrocarpa, Q. bicolor, Q. rubra, Q. tinctoria, Q. palustris, Q. imbricaria, Q ilicifolia, Betula pumila, Corylus Americana.

26. SALICACEÆ.

Salex amygdaloides, S. alba, S. discolor, S. nigra, S. tristis, S. rostrata, S. lucida, S. cordata, S. humilis, S. longifolia, Populus tremuloides; P. grandidentata.

27. CONIFERÆ.

Larix americana.

28. IRIDACEÆ.

Iris versicolor.

29. ARACEÆ.

Acorus calamus.

30. ALISMACEÆ.

Alisma plantago, Sagittaria variabilis.

31. CYPERACEÆ.

Scirpus atrovirens, S. microcarpus, S. cyperinus, Eriophorum Virginianum.

32. GRAMINÆ.

Panicus Crus-Galli.